4-18-2011

The Impact of Information Technology Management on the Efficiency of Top Liberal Arts Colleges

James E. Eckles

To the University Council:

The Dissertation Committee for James E. Eckles certifies that this is the final approved version of the following electronic dissertation: “The Impact of Information Technology Management on the Efficiency of Top Liberal Arts Colleges.”

Katrina A. Meyer, Ph.D.
Major Professor

We have read this dissertation and recommend its acceptance:

Bette J. Ackerman, Ph.D.

Patricia J. Murrell, Ed.D.

Jeffery L. Wilson, Ph.D.

Accepted for the Graduate Council:

Karen D. Weddle-West, Ph.D.
Vice Provost for Graduate Programs

THE IMPACT OF INFORMATION TECHNOLOGY MANAGEMENT ON THE EFFICIENCY OF TOP LIBERAL ARTS COLLEGES

by

James E. Eckles

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Education

Major: Higher and Adult Education

The University of Memphis

May, 2011

Dedication

To God be the glory.

Acknowledgements

I gratefully acknowledge all those who have provided me assistance and support through this process. To all of you at home, the University of Memphis, Rhodes, participating institutions, and elsewhere: thank you!

My studies have been funded in part by the Fellowship for Graduate Study from the Association for Institutional Research.

Abstract

Eckles, James Edward. Ed.D. The University of Memphis. May, 2011. The Impact of Information Technology Management on the Efficiency of Top Liberal Arts Colleges. Major Professor: Katrina Meyer

The purpose of this study is to provide administrators of liberal arts colleges with information that helps them improve their institutions' ability to graduate students. It investigates the relationship between IT and the efficiency of 35 highly ranked liberal arts colleges in graduating students. The study uses an operations research theory known as the resource-based view of the firm. Efficiency is based on the institutions' performance in graduating students relative to the resources available to them. A technical efficiency score obtained from data envelopment analysis is used as the dependent variable in a multiple regression.

The output in the data envelopment analysis is graduation rates. The inputs are cost per undergraduate, percent of faculty who are full-time, percent of entering students in the top 10% of their high school class, and the 25th percentile SAT score of the entering students.

Independent variables in the regression are 14 measures of information technology management selected from a secondary data source. An interrelationship digraph is used to analyze the literature on information technology management in higher education, leading to the identification of five primary themes: governance, investment, centralization, security, and alignment. The 14 measures were selected as proxies for these concepts and then entered in the order from drivers to effects. Fall enrollment was used as a control variable.

A regression model including fall enrollment and governance variables was significant. The only significant variable was the rank of the top IT officer, which had a negative coefficient. The model explained 13% of variance in efficiency of graduating students.

The conclusion is that our ability to graduate students is impacted, though admittedly only moderately, by the choices we make in governing information technology at top liberal arts colleges. In these settings, having a top IT officer who is closer to the operational details appears to be more efficient than a high ranking top IT officer who has a broader view of the institution. Recommendations for administrators of these schools are provided. Future research directions are enumerated.

TABLE OF CONTENTS

Chapter 1

Introduction

Statement of the Problem

In the face of economic pressure, college and university administrators have a strong motivation to find innovative ways to make their institutions more efficient in order to survive (Graves, 2001). As information-centric organizations (Sabherwal & Kirs, 1994), colleges and universities can commonly seek efficiencies through the use of information technology. Operations research suggests that in other industries, information technology can indeed determine how effective organizations are in combining resources to produce goods or deliver services (e.g., Bharadwaj, 2000; Melville, Kraemer, & Gurbaxani, 2004).

The problem, then, is this: what (if any) value does information technology (IT) provide to liberal arts colleges in their mission to graduate students, controlling for the primary institutional resources (like money, faculty, and student ability) that contribute to graduation rates? More specifically, are particular information technology management practices related to the ability of a liberal arts college to make the most of the resources it has available to graduate students? Are there differences in how liberal arts colleges manage information technology that are related to differences in their utilization of limited resources?

Statement of the Purpose

The purpose of this study is to provide administrators of liberal arts colleges with information that helps them improve their institutions' ability to graduate students. A demonstrated relationship (or lack thereof) between IT and the efficiency of colleges in graduating students will put both IT investments and IT management practices in a new light. To this point, there has been little investigation into the relationship between IT management and the ability of liberal arts colleges to effectively achieve their mission to graduate students.

Information technology does not by itself create graduates, research, or any other type of higher education outcome. IT is presumably an investment that extends or enhances an institution's ability to produce these outcomes (McRobbie, 2007). It is reasonable, therefore, to assume that IT investments and practices may have an impact on the efficiency of an organization in achieving outcomes, either by increasing efficiency or capacity. An example of increasing efficiency is electronic journal databases; being able to search through thousands of issues of journals electronically makes the discovery stage of the research process much more efficient and effective. Another example of increasing capacity is online learning; with an online course management system, the number of students an institution may teach need not be limited by the number of classrooms available on campus. Melville et al. (2004) pointed out that performance gains are often not realized in profitability but rather in improved quality or lowered costs for the end consumer, just as one would expect in a non-profit industry like higher education.

Multiple studies of IT business value outside higher education have found significant and positive relationships between IT investment and organizational performance (e.g., Bharadwaj, 2000; Melville et al., 2004; Oh & Pinsonneault, 2007). Higher education research posits that the purpose of investing in IT is to provide resources for creating educational and research outcomes like graduating students and publishing peer-reviewed research (McRobbie, 2007). Similar research outside higher education more specifically focuses on IT's impact on firm value, productivity, or efficiency (e.g., Ravichandran & Lertwongsatien, 2005). Both within and outside higher education, empirical research has yet to converge on a consensus as to whether IT clearly impacts institutional performance and, if it does, precisely what IT administrative choices best serve higher education institutions (Carr, 2003; Fernandez, 2008; Katz, 2007).

Potential Significance

This study may provide two contributions to our understanding of higher education. The primary goal is to provide evidence to either support or refute the assertion that IT is a strategic investment for higher education institutions and that it is significantly related to overall institutional performance in producing graduates. In seeking that evidence, a secondary goal will be to explore specific operationalized constructs that can be used for measuring IT management in higher education contexts. If indeed evidence to support IT as a positive factor in institutional efficiency is found, those constructs will provide insight for practitioners looking to improve their own institutions.

Theoretical

The theoretical basis for this study is the resource based view of the firm (RBV), drawn from operations research. The theory states that organizations (including higher education institutions) exist as a framework for combining bundles of resources in a unique way. In higher education, resource bundles might include such things as faculty expertise, facilities, finances, student ability, and information (Barney, 1991; Conner, 1991). Technology is a part of the framework by which those resources are combined to produce students with degrees. Therefore, differences in the ways institutions manage technology and information may result in differences in the efficiency with which those institutions graduate students.

One of the difficulties in studying higher education (or any primarily non-profit industry) through theoretical lenses developed in management or economics is determining the dependent variable that represents institutional performance. Obviously *profit* has limited meaning in the non-profit higher education context. Outcomes studied specifically for higher education institutions include graduation rates, retention rates, etc. However, measuring merely the levels of outputs introduces undesirable issues of scale and resource availability (Archibald & Feldman, 2008). This can be addressed by studying the efficiency of organizations, that is, the level of output relative to levels of input. One of the core assumptions of RBV is that institutions are seeking to maximize the efficiency of their product (or service) production and distribution (Conner, 1991). Indeed, some research has suggested that in industries like higher education, the benefit of IT is more likely to come in the form of efficiency gains than anything else (Melville et al., 2004).

Research Questions

The null hypothesis for this study may be stated as such: There exists no statistically significant relationship between the dependent variable, technical efficiency (representing efficiency at graduating students), and the set of 14 independent variables representing information technology management practices. The 14 independent variables are grouped and entered into the analysis in the manner suggested by a structured analysis of higher education IT management literature. If the null hypothesis is rejected, then two follow-up questions will be pursued: 1) Is the relationship between efficiency and IT management a positive relationship as theory predicts? 2) What are the most important factors in information technology management in terms of their contribution to explaining the observed variance in efficiency? If the null hypothesis is not rejected, then the conclusion will consider why no relationship appears to exist where theory predicts it might.

Methodology

The methodology for this study involves two steps. First, efficiency scores are calculated for each subject institution. These scores are calculated by applying an existing data envelopment analysis model for higher education efficiency to the institutions; the model incorporates data from publicly available sources, primarily the Integrated Postsecondary Education Data System (IPEDS). The second step is to then use those efficiency scores as the dependent variable in a multiple regression. The aim is to determine if the selected measures of information technology explain a significant portion of the variance in efficiency among the institutions. If so, the obvious follow-up question is which of those measures is most important in explaining that variance. The methodology is described in greater detail in Chapter 3.

Definition of Terms

Information technology is understood to be the systems within an organization that "collect, process, store, analyze, and disseminate information" (Rainer, Turban, & Potter, 2007, p. 2). These systems include not only hardware and software but also people and processes.

Data envelopment analysis (DEA) is a non-parametric statistical procedure that is used to determine the relative efficiency of a group of institutions (Charnes, Cooper, &

Rhodes, 1978). Each institution's efficiency is measured relative to the best observed performance among the institutions at various levels of input. *Inputs* in this context are resources used in the delivery of a service, such as graduating a student. Examples of inputs used in this study are student ability, faculty ability, institutional commitment, and money.

Those institutions that produce the greatest output (in this case, the highest graduation rate) for any given level of input are deemed *technically efficient*, and the outer edge of data represented by these technically efficient institutions is known as the *production frontier*. The production frontier is the greatest efficiency currently demonstrated to be possible by existing processes (Charnes et al., 1978).

The efficiency of each institution is expressed as a *technical efficiency (TE) score*. The TE score is the ratio of an institution's output divided by the output – as predicted by the DEA production frontier – that would be produced by a perfectly efficient institution with the same inputs.

Digraph is a contraction of *directional graph*. It is a visualization of items and unidirectional relationships between them.

Assumptions

A number of assumptions underlie this study. The assumptions are related to the means of assessing institutional efficiency, the means of assessing IT management practices, the precepts of the analytical techniques, and the data that are fed into the analysis.

An assumption is made that the liberal arts colleges evaluated in this study have a common goal: to legitimately award bachelor's degrees to as many of their enrolled students as possible. The study assumes that, unlike community colleges or some university programs, these liberal arts colleges are not preparing students explicitly for transfer to other institutions or for non-degree-awarding completions such as certifications or licensure. To that end, six-year graduation rate is assumed to be an effective measure of the output of the educational processes at these colleges. It is further assumed that the inputs used in the efficiency calculation accurately reflect the resources, as defined by the resource based view of the firm, that are combined to produce graduates.

The data used both to calculate efficiency and to measure information technology management practices are self-reported by the institutions. These data are assumed to be true. Because they are secondary data, it is further assumed that the data as they were reported to the Department of Education and Educause are stored without error in their respective repositories.

Perhaps the most critical assumption of this study is the presupposition that there are real differences in the way information technology is managed at these institutions. Additionally, the study assumes that the management practices were equally understood by participating institutions during their data submission.

Limitations

The generalizability of this study is limited due to the sampling procedure. Out of 221 institutions in the United States categorized in 2008-2009 as baccalaureate liberal arts institutions under the Carnegie 2000 scheme, only 35 are evaluated here. All of the institutions belong to a particular data sharing consortium (which according to contractual obligation with the consortium is not disclosed here), and all volunteered to have their data used in this study. While the sample represents a large percentage of all liberal arts colleges in the United States, one must be cautious about generalizing the findings in this study to the population of all American liberal arts colleges. Subjectively, the sampled institutions have higher levels of prestige than those not sampled, and objectively the sampled institutions generally have much higher endowments than the non-sampled institutions. The findings here certainly cannot be generalized beyond liberal arts colleges located in the United States.

The unit of analysis in this study is the college. Consequently, the findings from the study will be of limited value in terms of explaining specific student-level outcomes beyond graduation. The study does not attempt to assess or even address the quality of education that graduates of the sampled institutions receive. It does not attempt to evaluate specific outcomes such as critical thinking, analysis, or writing skills. Similarly, the study does not investigate specific processes within the colleges. Examples of processes might be online learning, enterprise resource planning, or student relationship management.

Organization of the Study

To set the context, this study continues in chapter 2 with a review of the theoretical basis of the study, the resource-based view of the firm. A brief review of the foundations of the theory is provided as well as a look at its application within higher education. Next comes an overview of the MIS literature related to IT's value to organizations; of particular importance in this body of research are hints to operationalizing the information technology metrics. Much of the MIS research utilizes a RBV theoretical approach. From a general overview of IT value to organizations, the chapter dives more specifically into information technology management in higher education. This body of literature provides insight into the specific aspects of IT management that may impact institutional performance. Five themes emerge from the literature and their relationships are illustrated through interrelationship digraphing. Finally, a brief look at the evolution of the understanding of efficiency in higher education sets the stage for the study's methodological investigation.

In chapter 3, the methodology of the study is explained in detail. First the population and sample are identified and described. Next, the variables of the study are enumerated and descriptive statistics are provided. This section also describes the sources and means of collection of the data. Finally, the method of analysis is explained. There the assumptions that underlie the analytical techniques are addressed. The actual results of that analysis are presented in chapter 4.

The substantive meaning of those results is the subject of the final chapter. A guide is provided for interpreting the results, and a discussion evaluates what those results mean in terms of the hypotheses and the research questions. The discussion leads to implications for administrators at liberal arts colleges, both within and outside IT departments.

Chapter 2

Literature

Introduction

Three main bodies of literature are relevant to the current study. The first area of literature reviewed covers the theory of the resource based view (RBV) of the firm. Much of that literature derives from the field of operational research, but RBV has been applied in higher education and this review also examines those applications. The RBV literature situates the current study in the context of its theoretical framework. The next area reviewed is the value of IT to organizations, which hails primarily from the field of management information systems (MIS). This body of literature establishes the relevance of IT to operational outcomes like graduation rates. Interestingly, the RBV literature and the IT value literature overlap; some scholars of IT value have gone to great lengths to justify the use of RBV in their studies. Finally, the literature on the management of information technology specifically in higher education helps one understand the structure and purpose of current management practices within this industry. The question of how IT impacts the efficiency of colleges lies at the nexus of these three areas of literature.

Resource Based View

The theoretical basis of this study is the resource based view of the firm. That theory states that organizations exist as a framework for combining bundles of resources in a unique way. In higher education, resource bundles might include such things as faculty expertise, facilities, finances, student ability, and information (Barney, 1991; Conner, 1991). This concept is depicted in Figure 1. The theory found its intellectual roots in the theory of firm growth (Penrose, 1959). The theory of firm growth accentuated the role of resources in institutional growth and asserted that a firm "is basically a collection of resources" (Penrose, 1959, p. 77). Birger Wernerfelt (1984) pulled together Penrose's foundation with research on imperfect and monopolistic competition to propose the resource based view of the firm. The core supposition in RBV is that superior performance of a firm relative to other firms in the industry can be explained by the unique resources that the firm has acquired and its capabilities in transforming those resources into goods or services.

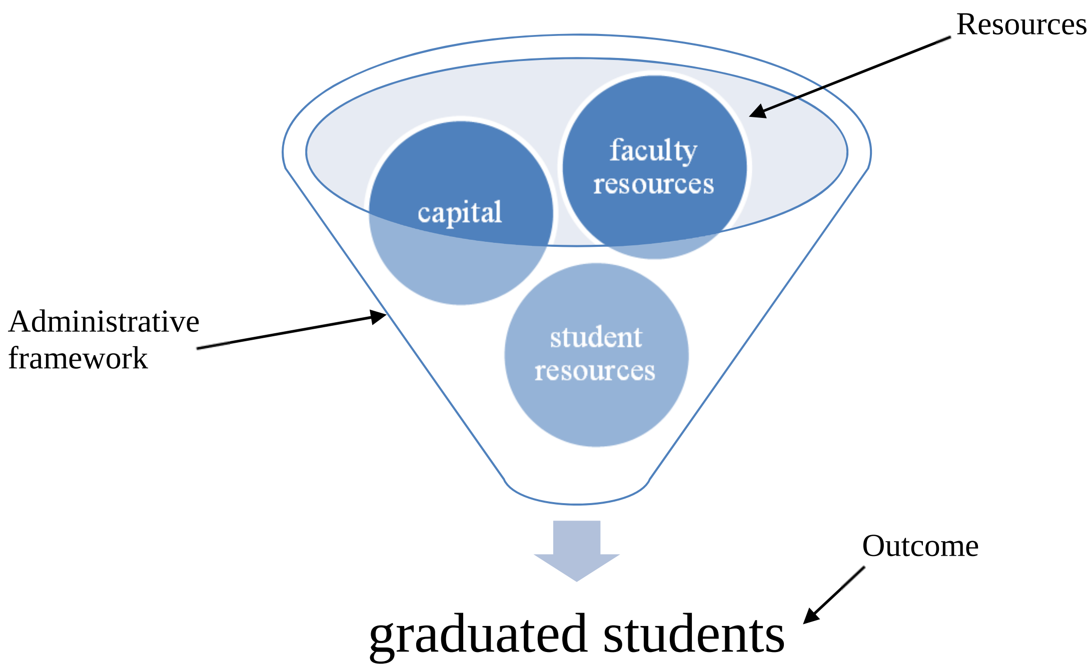

Figure 1. Resource-based view of the firm applied to higher education

Jay Barney (1991) sharpened the theory by more precisely identifying the types of resources that can help a firm maintain a strategic advantage; those were resources that are valuable, rare, imperfectly imitable, and not substitutable. It is not sufficient that a resource is merely valuable to the organization or that it is difficult to obtain; it must also have the characteristics of being difficult to copy and must be something that has no substitute. Some examples of such resources are, according to Barney (1991), found among a firm's intangible assets. Relevant to the present study, he specifically mentioned management skills and information as such intangible assets.

Barney's (1991) treatment of RBV was also useful because he defined key concepts that are central to the theory such as *firm resources*, *competitive advantage*, and *sustained competitive advantage*. He also provided a thorough review of the development of competitive advantage theory that led up to RBV. While the resource characteristics of value, rarity, inimitability, and non-substitutability have become cornerstones of RBV theory, Barney offers little insight into how he established those four characteristics. His reasoning in defending each characteristic was strong, but it was not until researchers had more thoroughly tested RBV that those characteristics might be said to be well-established precepts.

Another early and influential article on RBV was by Peteraf (1993). Her work in modeling competitive advantage in the context of resources gave a more grounded basis for the four characteristics of resources that Barney identified. While she did not directly compare her four "cornerstones of competitive advantage" (p. 186) to Barney's four characteristics, it is not difficult to make connections between the two. Consequently Peteraf's careful economic derivation of her cornerstones provided some of the initial support for Barney's refinements of RBV. Those four cornerstones are heterogeneity, *ex post* limits to competition, imperfect mobility, and *ex ante* limits to competition. Heterogeneity means that each institution has resources to work with that are in some way distinct from the resources available to other institutions. *Ex post* limits to competition are conditions that allow an institution to continue to benefit from a superior strategic position after that position has been achieved. Imperfect mobility means that the resources held by each institution cannot be easily traded with other institutions. *Ex ante* limits to competition means that the strategic positions an institution can take up to gain an advantage are not obvious; they require insight and foresight to locate.

Additionally, while synthesizing the results of research done on RBV to that point, Peteraf (1993) linked RBV to efficiency. She stated, “One might describe productive factors in use as having intrinsically differential levels of ‘efficiency.’ Some are superior to others. Firms endowed with such resources are able to produce more economically and/or better satisfy customer wants” (p. 180). She went on, referring to the now famous Prahalad and Hamel (1990) concept of core competencies, to describe learning and knowledge-based firms as having key resources that have the opportunity to create sustained advantage. Such an assertion is useful for the current study; colleges are, if anything, learning and knowledge-based organizations. Her singling out of these types of firms and her link of RBV to efficiency both set the direction for future research and has a direct bearing on this current study.

In a retrospective on his 1991 piece published a decade later, Barney along with two colleagues observed that RBV has important uses in management information systems scholarship and IT value studies (Barney, Wright, & Ketchen, 2001). At that time, Barney’s judgment was that evidence did not support the hypothesis that information and communication technologies were able to generate value for a firm. His reasoning was that technologies that are easily transferred among competing institutions cannot result in sustained advantage. However, he foresaw that firm capabilities related to information technology might be a source of such advantage. His example was "the interface between skilled users and ICTs [Information and Communication Technologies]" (p. 636). The lesson was clear, though: it is not the systems themselves which allow a firm to excel, it is the management and leverage of those systems as firm resources. For that reason, the current study focuses not on specific technologies but on the ways in which colleges manage them.

Multiple empirical studies of IT's impact on institutional performance (e.g., Bharadwaj, 2000; Huang, Ou, Chen, & Lin, 2006; Melville et al., 2004) have since utilized RBV as their foundational theoretical framework. In one particularly useful review, Melville et al. (2004) document their selection of RBV by comparing it to alternative methods used in 200 articles they reviewed related to IT business value. In their attempt to build an integrative model of IT business value, they chose RBV over microeconomic models such as production functions or option pricing and over industrial organization models such as game theory, agency theory, or transaction costs. While the reasons for doing so were myriad, they summarized their choice by quoting Peteraf and Barney (2003) who described the resource based view as "the integration of a management perspective with an economics perspective" (p. 309) that "provides the balance that we require for the development of an integrative IT business value model" (p. 291). Melville and his colleagues' extremely detailed justification for use of RBV versus multiple alternatives for IT business value studies provided a strong foundation for future research using RBV.

Perhaps the primary alternative to RBV in operational research literature is the contingency-based perspective. That theory states that alignment of infrastructure and strategy leads to superior institution performance and misalignment leads to poor performance (Doty, Glick, & Huber, 1993). However, even articles that favor other theoretical approaches like the contingency-based perspective recognize that RBV is a valid and appropriate analytical framework that is complementary to other theories (Oh & Pinsonneault, 2007). A recent article in the management literature goes further. It argues that organizations can fall into a trap. They can begin failing to pay attention to the actual performance of the organization when they focus entirely on the strategic alignment of IT and business. It is this alignment that is central to the contingency-based perspective (Shpilberg, Berez, Puryear, and Shah, 2007).

Some criticism does exist for RBV. Observing that while RBV is "one of the most widely accepted theories of strategic management" (p. 121), Newbert (2007) performed a meta analysis of empirical articles grounded in RBV. His goal was to assess the empirical support for RBV. His findings were mixed; modest support for RBV was found overall, but that support varied widely depending on the independent variables and theoretical approach utilized by each study. His recommendation was to take a cautious approach in applying RBV, taking advantage of later research on RBV. Similarly in a look at forces of strategic change in higher education, Zajac and Kraatz (1993) contrasted their findings with what RBV might predict. The differences in their observations vis-à-vis predictions based on RBV theory led them to conclude that RBV may be more suited to cross-sectional analysis than longitudinal analysis. In other words, RBV is more useful when looking at performance at a specific point in time rather than looking at performance changes over an extended period of time. This is because RBV does not take into consideration changes in performance that result from the acquisition of new resources. In higher education, that might be an infusion of cash from a major gift or a sudden increase in the scholarly profile of the student body.

With Zajac and Kraatz as a starting point, RBV has been repeatedly considered for application to higher education as an industry. Conner (1991) pointed out the industry-agnostic nature of RBV by observing that outstanding performance results "primarily from the acumen or luck of the firm in acquiring, combining, or deploying resources, rather than from the structure of the industry in which the firm finds itself" (p. 132). In two simultaneous but independent studies, Powers and McDougall (2005) and O'Shea, Allen, Chevalier, and Roche (2005) used RBV to study higher education institutions on their ability to transfer technology generated from faculty research activities. Dill (1999) used RBV as the basis for understanding academic institutions as learning organizations. Lynch and Baines (2004) discuss the employment of RBV for strategy development for the United Kingdom's higher education system, though they incorrectly assume they are the first to apply RBV to higher education institutions. In all of these cases, higher education institutions were understood as the resource utilization framework, education was the service being produced, and resources included financial, human, and capital resources available to colleges and universities.

IT Value to Organizations

Does information technology affect the value of organizations? That is a question with which scholars in management information systems (MIS) have been grappling for about thirty years. A review of the literature implies a tentative agreement that IT has specific value to firms, but a strong consensus on the topic does not exist either among contemporary scholars or through the research across time. Across researchers, issues of operationalization of variables, theoretic approach, and data availability have resulted in mixed findings. Across time, the changing nature of information technology seems to have had an influence on research findings. In the early 1980s, information technology was largely a strategic investment in its own right. Toward the 1990s and especially in the 2000s, information technology became more ubiquitous and perhaps more difficult to use as a lever for sustained competitive advantage. Consequently, later studies in information technology tend to focus less on software and hardware assets and infrastructure and more on institutions' capabilities in harnessing IT investments towards achievement of the institutional mission.

Radhakrishnan, Zu, and Grover (2008) provide a useful and recent review of the literature in this area. They organized a number of studies of IT value according to whether their focus was IT's impact at the economy level (the collective performance of an entire nation's industries), industry level (the collective performance of the institutions within a single industry), or firm level (the performance of a single institution). Thirty studies from 1986 through 2003 were evaluated. Fifteen of the studies observed a positive relationship between IT and some measure of output, 13 had mixed findings or observed no relationship at all, and two studies showed a negative relationship. One of the shortcomings of this review was the age of the studies evaluated (all but two were published before 2000). The studies do appear, however, to provide a broad representation of the field. Many come from the standard journals, *MIS Quarterly* and *Journal of Management Information Science*, with the rest coming from a variety of other journals in management and economic fields, working papers, books, and conference proceedings. Consequently, the results are not limited to a narrow venue that could result in findings skewed by editorial bias. The conclusion from their literature review is that the majority of studies have shown some positive value between IT and results, but about half of the research studies showed no or mixed relationships, and two studies even pointed to negative findings.

A focus of the Radhakrishnan et al. (2008) article was that to successfully link IT to business value, an investigation must focus on IT processes and practices rather than the blunt instrument of IT investment. Otherwise a host of intervening variables, primarily how investments are allocated, obscure the impact of information technology. An article by *Harvard Business Review* editor Nicholas Carr (2004) extended that concept and also illustrated how information technology's position in competitive advantage has changed over time. He likened IT to other game-changing technologies of the past like electricity and railroads. Early in a technology's lifecycle, individual institutions are able to use the technology to gain an advantage because it is not widely available and competitors can not copy its use. Eventually, though, the technology becomes commoditized (that is, there are no qualitative distinctions among the technologies at various institutions) and, like electrical service, no longer offers a competitive advantage. A firm can only be at a disadvantage if it does not use electricity. What is still possible though, Carr conceded, is that an institution can find innovative ways to employ a technology, even if it has become commoditized, to create an advantage. He argued that if information technology is becoming commoditized, the only way institutions can realize performance gains from IT is by the way they use it (such as the specific types of technology invested in or the specific uses of that technology), not by the raw amount they invest in it. While Carr's article created considerable criticism in the IT industry and popular press, his thesis is based on sound historical perspective.

These relatively recent looks at IT value are the tail end of a long tradition of research in the MIS field that seeks to determine the relationship between information technology and business value. An oft-cited origin of this work is from Crowston and Treacy (1986). In their review of the previous decade's research literature, they asserted the implicit understanding of IT as impacting the "bottom line of the business" (p. 1) while lamenting the fact that this implicit assumption had rarely been tested. From 1975 to 1985, they found only 11 articles relating IT to enterprise-level performance (that is, the performance of the entire institution as opposed to the performance of the IT department within the institution). Crowston and Treacy rightly pointed out that one of the primary flaws in those early studies was a lack of a theoretical framework for processes within a firm. From Crowston and Treacy's call for improved theory-based empirical research flowed a stream of work in the MIS discipline. Among the issues MIS research has continually grappled with are the issues of operationalizing measures of information technology and employing those measures in a theoretical framework.

In a literature review looking this time at nearly 100 research articles covering the time period from 1993 to 1998, Chan (2000) attempted to categorize IT value measures. Her motivation for doing so was the emergence of what came to be known as the IT productivity paradox. The paradox was the observation of continually increasing computing power that was accompanied by stagnating productivity across the national economy (Brynjolfsson, 1996). Chan was seeking to determine if that paradox was the artifact of poor measures of IT value. Unfortunately, her article appears to suffer from a perception that qualitative and quantitative measures are in effect interchangeable, that the two can answer the same questions in the same ways. The article does not present an understanding that quantitative research often seeks relationships and generalizability, while qualitative research often seeks meaning. Consequently, the conclusion that qualitative measures of IT value were at that point underutilized is a specious one.

Chan (2000) provided value in two important ways. First, she provides a useful analysis of the research that had been conducted on IT value during 1993 to 1998 and the measures employed by those studies. Second, one of the important lessons Chan observed as emerging in the literature from the five year period was that “an assessment of IT value that relies heavily on a few key numbers at a single point in time will be incomplete and possibly misleading” (p. 245). Other researchers such as Ravichandran and Lertwongsatien (2004) and Santhanam and Hartono (2003) picked up on this and made the time dimension a component of their analysis schemes.

Measurement issues are a persistent theme in MIS literature. DeLone and McLean (1992) had proposed an information systems (IS) success model in an attempt to address both questions of theoretical foundation and variable operationalization. A decade later in 2003 they revisited the model, making only minor adjustments. The model’s primary basis is the adoption of an information system by its users. That is to say that DeLone and McLean understood the organizational impact of an information system as being proximately caused by the accumulated impact on the individual users of the system in the organization. According to the model, the organizational impact derived ultimately from information quality, system quality, and service quality mediated by intention of individuals to use the system and the satisfaction users have with the system. Information quality is essentially a measure of how accurate or correct the information in the system is, while system quality is a measure of how well the system performs technically. Service quality is poorly defined in the 2003 article, but is essentially how well the information system support organization provides service to the users of the information system.

While DeLone and McLean are clearly fans of their own model, they are not without detractors. Citing two others studies, Ravichandran and Lertwongsatien (2004) criticize the model saying, "the link between individual level system use and organization performance improvement is not automatic, and IS success models have to more directly link IS activities with firm performance" (p. 260). Additionally, in an empirical test of the DeLone and McLean model, Iivari (2005) found mixed results for the various testable propositions implied by the model. Nonetheless, the DeLone-McLean information system success model is apparently quite popular, with Iivari pointing out that, as of 2002, the 1992 DeLone and McLean article had been cited 235 times. In late 2010, the Google Scholar search engine indicated 3,324 scholarly citations to the same article and 1,480 scholarly citations of their 2003 update article. That popularity may be due to the usefulness of the model in identifying IT management practices that can influence information system success and in identifying success as the impact a system has on an organization. Both of those concepts are critical to the current study.

Other measurement issues that have emerged are the validity of perceptual measures and the issue of proxies. Many researchers have found that direct measures of information technology in a firm – such as the exact dollar-value benefit of a new system implementation – are difficult to come by. Operating under the principle that a poor proxy is better than none, researchers have sought out all sorts of indirect measures of information technology. A couple of studies were useful in evaluating these proxies. Tallon and Kraemer (2007) applied sensemaking theory and partial least squares methodology in their search for evidence that the responses of executives to questions regarding their perceptions of technology practices and impacts were "more fact than fiction" (p. 13). Upon constructing a model that linked process level IT impacts (for example, reduced variance in supplier lead times) with firm level IT impacts (such as reduced labor expenses) and firm performance (profit), the researchers then evaluated the results of the model using objective measures versus subjective executive perceptions. The executive perceptions were found to be "valid, accurate, and reliable insights" (p. 42). Tallon and Kraemer's findings are believable in part because of the care taken in their methodology. A number of assumptions regarding the model's validity and the quality of the variables were explicitly checked and reported in the analysis. Each testable proposition was tested using partial least squares factor analysis.

Similarly, Stoel and Muhanna (2007) found themselves using, validating, and defending proxies for constructs like externally focused IT capabilities or technology enabled business practices. The primary goal of the article was to understand how industry and capability type factor into contributions of IT to firm value. But in constructing and evaluating their contingency model, they were forced to deal with the issue of proxy measures. Unfortunately their defense of proxies is a bit muddled by confounding the issues of secondary data and proxy measurements. As with the current study, the secondary data source employed by the researchers prevented them from improving on issues of internal consistency. Their choices of proxies were also limited to the measurements available in the secondary data source. Still, their assertions ring true that direct measurements of some IT capabilities are simply too difficult or costly to obtain for the value they provide, and proxies are a reasonable alternative. In support they referred to past research that supported their particular proxy selections. In their case, the proxies were innovation as a proxy for externally focused IT capabilities and enabled business practices as a proxy for internally focused IT capabilities.

One particularly valuable examination of measurement issues was from Wade and Hulland (2004). The two synthesize eight key information services resource types based on the findings of 15 major studies of IT value. The resource types they identified were external relationships, market responsiveness, Information Systems (IS)-business partnerships, IS planning and change management, IS infrastructure, IS technical skills, IS development, and cost effective IS operations. They then mapped these resource types onto a framework proposed by George Day (1994). The result was a two-level measurement framework that considered information technology constructs as resources at the firm level. The top level of categorization referenced the organization (such as the IT division), relationship with external partners (outside-in), capabilities within the organization (inside-out), and capabilities that integrate the two (spanning). Outside-in resources were then broken down into external relationship management and market responsiveness. Spanning resources included Information Systems (IS)-business partnerships and IS planning and change management. Finally, inside-out resources included IS infrastructure, technical skills, development, and cost effective IS operations.

Beyond the issues of measurement, one of the topics that recurs in the literature is the value of looking at IT's impact on efficiency as opposed to other types of institutional performance. One such example is when Melville et al. (2004) identified efficiency as the dependent variable in two of the five major questions asked about IT business value. In fact, those were *the* two questions that focused on firm-level performance. One question was whether IT is related to efficiencies, and the other was how IT generates such efficiencies. While hard answers to the question of "how" remained elusive, they did find "abundant empirical evidence [supporting] the claim that in the aggregate, the technological IT resource has economic value" (p. 300). Their findings suggested that the remaining question for future research was not a matter of <u>if</u> IT relates to efficiency, but rather <u>how</u>.

Thatcher and Oliver (2001) made distinctions between production efficiency, product quality, and productivity in terms of the impact of technology investment. Their study provides a useful operational definition of efficiency: "to produce a <u>given</u> product or service (of given quality) with fewer resources" (p. 18), with the original emphasis indicating that efficiency improvements must assume constant quality of the service. Efficiency in their terms is understood as the amount of input required to produce a fixed output. Productivity on the other hand is the ratio of actual output value to units of input value. Their conclusion is that technology investments in production efficiency reduce the cost to design and deliver a service, resulting in a better quality service at a higher cost to the consumer. In higher education, one would understand efficiency then as the ability to produce more graduates with fewer or the same resources (money, full-time faculty, student ability, etc.). Productivity, on the other hand, would be increased quality of offerings with the same or greater resources (for example, better internships and research opportunities at a higher net tuition cost for the student).

Ravichandran and Lertwongsatien (2005) was yet another article that made the case for using efficiency as the measure of institutional performance. Their review of literature on IT and firm performance indicated that those studies using process efficiency, like the ability to provide customer service with lower labor expenditures, reported more consistent results than studies using other measures of institutional output or performance. In that article, they also made the case for industry specific studies such as the present study. They pointed out that "market sensitivities to price and product quality have been found to affect the relationship between IT investments and firm performance…[and] these relationships have been found to vary across industries" (p. 240). They continued by indicating that more industry-specific studies were needed to contribute to "deeper knowledge about the contingencies under which IT investments enhances firm performance" (p. 240).

Throughout all of the IT value literature, an interesting unifying aspect is how often similar models are employed. Typically these models identify variables related to IT practice as independent variables driving firm performance through some intervening variable or condition. With only a couple of exceptions, all seem to employ the input/process/output archetype suggested by Crowston and Treacy (1986). Table 1 below illustrates this point by comparing the components of various IT value models found in the literature. Wade and Hulland's (2004) review information systems research using the resource-based view of the firm even adopts this archetype. Inputs are the productive use of firm resources where are valuable, rare, and can be made of use. The intervening item is short term competitive advantage, that is the gains that an institution achieves for a brief duration, achieved by processing of the resources. The output or result is sustained advantage due to resource imitability (it can be copied), substitutability (other resources can be used instead), and mobility (the resource can be moved or traded). Indeed, among the few models that do not adopt Crowston and Treacy's input/process/output archetype is the IS sustainability framework depicted as a flowchart in Doherty and Terry (2009). Melville et al. (2004) presented a layered model that takes into account various levels of analysis, but at its core at the firm level, the archetype persists. These consistencies in models lend support to the current study's evaluation of IT's impact on the efficiency of college operations wherein IT practices are the independent variable, the administrative framework of the institution is the intervening item, and efficiency of the institutions is the dependent variable.

Table 1

Comparison of IT Value Models 1

Researchers	Ind. variable	Intervening item	Dependent variable
Crowston & Treacy (1986)	Input	Process	Output
Chan (2000)	IT	Structure and IT Processes	Performance
Griffiths & Remenyi (2003)	IT investment	Product Differentiation Ease of Search	Price Market Share Revenue
Melville, Kraemer, & Gurbaxani (2004)	IT resources Complementary Organizational Resources	Business Processes Business Process Performance	Organizational Performance
Tallon & Kraemer (2007)	Process-level IT impacts	Firm-level IT impacts	Firm Performance
Radhakrishnan, Zu, & Grover (2008)	IT	Management Processes and Capabilities Operational Processes and Capabilities	Firm's Performance
Stoel & Muhanna (2009)	Internal IT capabilities External IT capabilities	Environmental conditions	Firm Performance
Mittal & Nault (2009)	IT Labor Non-IT Capital	Effective Labor Effective Non-IT Capital	Output

IT Management in Higher Education

"IT is seen as a critical system within the institutional organism – the circulatory system that moves the information that is increasingly the lifeblood of many organizations" (Kvavik & Voloudakis, 2006, p. 88). One can hardly deny that higher education institutions are information-centric organizations (Sabherwal & Kirs, 1994); their purpose is to generate and share knowledge. But the practice of managing a higher education organization has become an increasingly complex task. Competitive pressures force institutions to develop strategies for establishing and defending a position that allows them to thrive (Graves, 2001).

The question of some scholars, then, is whether information technology is truly a source of competitive advantage for colleges and universities. At the turn of the millennium, scholars such as Katz (1999) and Farrington (1999) doubted the importance of technology for higher education in the ensuing years. Katz was bold enough to predict that technology would indeed be the least important factor in an inevitable restructuring of the higher education industry. He saw quality and access as the most important factors, with technology at best providing a source of new revenue that could be reinvested in traditional collegiate instruction. Farrington's interest was more specifically in the role of technology at traditional residential undergraduate institutions, and like Katz, he did not anticipate that technology would be a significant driver of transformation or efficiency at these colleges.

Others agreed with this pessimistic view of technology. McClellan, Cruz, Metcalfe, and Wagoner (2006) went beyond the argument that IT is unlikely to result in cost savings or productivity increases, asserting that IT is really a labor-controlling device rather than a labor-saving device. They described an "academic technocracy" (p. 63) that oppresses the faculty and staff of higher education institutions by limiting opportunities for advancement via a flattened hierarchy and encouraging centralization of control while delegating only superficial tasks.

These pessimistic views, however, tend to be at odds with the majority of research related to the value of information technology both within and outside higher education. Whereas McClellan et al. (2006) saw technology-driven flattening of organizational hierarchies as an oppressor of the people, Battin (1989) argued the exact opposite. His position was that IT creates the possibility of decentralizing technical capabilities and empowering individuals. Similarly, Duderstadt (1999), writing in the same edited volume as Katz and Farrington, had a different interpretation on the potential impact of technology on higher education. While Katz and Farrington both spoke to the greater importance of access to and quality of higher education, Duderstadt observed that IT provides a way to overcome the barriers of space and time in delivering educational services and consequently increase access and quality. Others have espoused similar views, such as Barone and Hagner (2001) who foresaw technology transforming higher education and Gonick (2009) who likewise perceived the internet as a change agent that would eventually produce a new type of university.

The vast majority of research into the value of information technology has focused on business rather than academe (Albrecht et al., 2004). Indeed, a number of studies outside the higher education industry (Huang et al., 2006, is one example) clearly demonstrate that IT is an enabler of competitive advantage. EDUCAUSE president Diana Oblinger asked, “Are we doing the same things with technology, or are we taking advantage of the unique capability of technology and redesigning our activities?” (Oblinger & Hawkins, 2006, p. 15). Her working premise is that technology does not produce change directly; it is simply a medium for change. Technology allows for new and possibly novel means of teaching and managing institutional resources.

The premise of technology as a facilitator of new processes pervades the literature on the practice of IT management in higher education. One of the original chief information officers in higher education pointed out that, “Information technology is perhaps the enabling tool that will bring transformative change” (Penrod & Harbor, 2000, p. 2). Cavalier (2002) went one step further by observing, “New technology is more than just one of the forces transforming colleges and universities; it has influenced all others” (p. 14). Others describe information as lifeblood (Dhillon, 2001; Kvavik & Voloudakis, 2006) and as an operational resource on par with finances and people (Dhillon, 2001; Huang et al., 2006). This view of the importance of information as a resource appears to be echoed among practitioners, nearly 80% of whom indicated on one survey that IT was critical to their organizational success (Albrecht et al., 2004).

The Hoshin Planning technique of interrelationship digraphing can be used to help understand the relationships that have emerged in the literature among the primary themes that comprise the literature (Anjard, 1995). Interrelationship digraphing involves taking each pair of items (in this case the themes) and determining first whether any relationship exists between the pair and then which item in the pair comes first in a causal or temporal sense. By counting the number of times an item drives another item and subtracting from it the number of times the item is driven by others, one may arrive at a driver score. The item with the highest driver score is presumed to have the greatest impact on all other items; the item with the lowest driver score is presumed to be the primary effect of all other items. Items with scores in between may be understood as intervening variables. In this manner, the interrelationship digraph is a useful tool for tracking the relationships among the topics as they are revealed in the literature.

Five themes that emerged through the review of resources on IT management in higher education are alignment, centralization, governance, investment, and security, any one of which would qualify for book-length treatment. With a topic as broad as IT management in higher education, it would be impossible to exhaustively review the complete body of literature. Furthermore, while the five areas addressed here do not necessarily represent a complete inventory of the issues faced by IT practitioners, they do represent a strong core around which more tangential topics are built. Figure 2 illustrates the interrelationship digraph that is suggested by the literature reviewed.

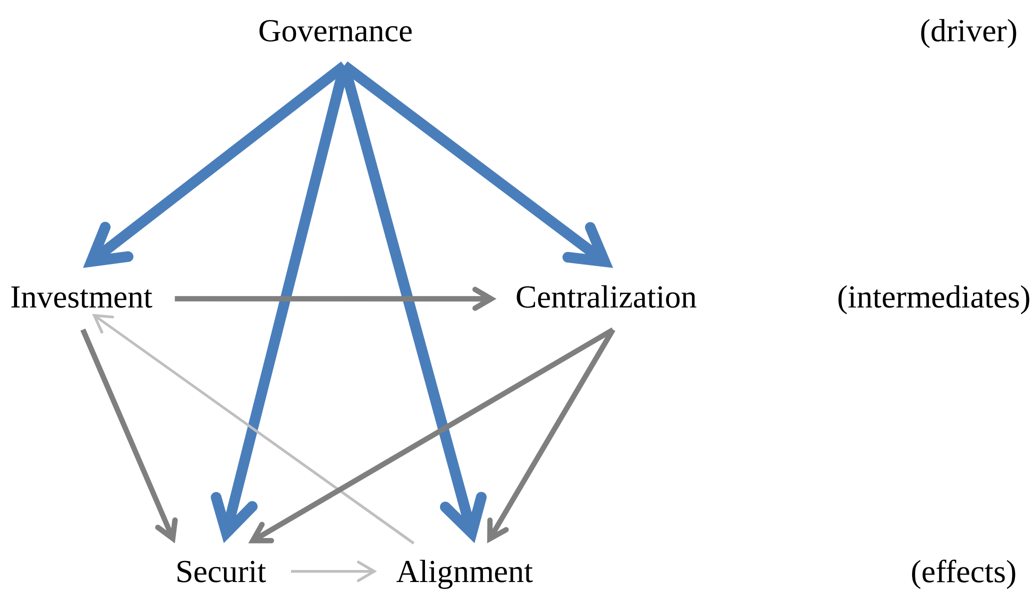

Figure 2. Interrelationship Digraph.

Governance consists of the “patterns of authority for key IT activities . . . including IT infrastructure, use, and project management” (Sambamurthy & Zmud, 1999, p. 261). *Investment* means the allocation decisions on how, when, and where to apply both financial and human resources to enhance information technology capability. *Centralization* is the degree to which IT functions are controlled by a single unit within the institution versus being spread out and embedded in other functional organizational units. *Security* is the collection of practices employed to maintain the secrecy and reliability of data, including safety from physical destruction. Finally, *Alignment* is the “linkage of business strategy, information technology strategy, organizational infrastructure and processes, and IT infrastructure and processes” (Luftman, Lewis, & Oldach, 1993, p. 198).

The digraph shows governance as the primary driver among the five topics. It is driving four other topics, and no topics are driving governance. Governance “causes” alignment in the sense that governance decisions will dictate the degree of alignment between a college or university’s IT organization and the overall institution’s goals (McCredie, 2006). Governance influences the degree to which an institution centralizes its IT resources (Neal & McClure, 2003), it approves and manages investments in IT (Nelson, 2003; Penrod, 2000), and security breaches are a potential cost of poor governance (McCredie, 2006).

Centralization and investment are intermediary topics. Both are drivers for two other topics and both are the effects of two other topics. Centralization has been shown to foster alignment (Acemoglue, Aghion, Lelarge, Van Reenan, and Zilibotti, 2007) as well as facilitate improved information security (Johnson, Mitrano, & Vernon, 2003;

Kvavik & Voloudakis, 2006). But governance decisions and investments in infrastructure are what determine the degree of centralization. Similarly, alignment and strategic planning set the priorities that drive investment that is approved through governance. But without sufficient investments in security, information resources are left exposed.

Alignment and security then are left as the primary effects. Security is primarily the result of decisions made through governance in the form of centralization and investment. Likewise, centralization, governance, and security are all shown to have an impact on an institution's alignment between organizational goals and information technology (Albrecht et al., 2004).

The relationships illustrated by the digraph will form the basis of the order of variable entry in the regression used in analysis. If this digraph captures real relationships, the management of IT within a college or university has a complexity that mirrors the complexity of the prototypical organizational structure of higher education institutions. Though the literature helps one understand the primary topics of conversation that have emerged around higher education IT management, no grand unified theory exists for leveraging information resources to the betterment of higher education institutions.

Conclusion

The literature reviewed in this chapter can be summarized in three points. First, the resource based view of the firm is appropriate for the study of IT value and for the study of higher education phenomena. Second, while a consensus does not necessarily exist on IT's impact on organizational value, it is clear that IT at least has the potential to influence the outcomes of colleges and universities. Third, the literature has uncovered the major factors that play into the management of IT within the higher education realm specifically. This study exists at the intersection of these three bodies of literature. Taken together, these three areas of literature seem to beg the question as to whether and to what degree IT impacts graduation rates at colleges and universities. The remainder of this study attempts to address that question in the limited context of top liberal arts colleges. The next chapters are devoted to describing the methodology used to answer this question, the results of the analysis, and the conclusions that can be drawn from the analysis.

Chapter 3

Methodology

Population and Sample

The population for this study is the set of highly regarded liberal arts colleges in the United States. Narrowing down the sample begins with the 93 highly-ranked liberal arts colleges sampled in a recent study of the efficiency of liberal arts colleges (Eckles, 2010). The institutions were chosen from among the top approximately 100 liberal arts colleges in the 2008 *U.S. News and World Report* (USNWR) special issue *America's Best Colleges*. The institutions studied are chosen not because their rankings are of material importance. Rather, the rankings indicate that the institutions have substantially similar resources and results, and they market themselves similarly to similar students. The rankings are based primarily on resource measures with occasional outcome measures. The rankings are used by prospective students and their parents to help identify colleges they may apply to. The institutions outside the ranked group tend to have less national reach as evidenced by the lower percentage of out-of-state students and consequently have different recruiting methods and resultantly different student bodies. For that reason, institutions with special missions such as historically black colleges, military colleges, business colleges, etc. were removed in the Eckles (2010) study.

The 93 remaining institutions were contacted and asked for the responses they would have made to the EDUCAUSE Core Data Service survey as well as their written permission to use their data for published research. Eighty-five of those institutions responded in the affirmative. One institution was dropped due to its test-optional admissions procedures and subsequent choice not to report the test scores for any of its admitted students. Ultimately, only 34 of the 85 actually provided responses sufficient for the statistical analysis performed in this study. This results in an effective response rate of 37%.

All 34 of the sampled institutions are liberal arts colleges ranked in the top 100 of the *U.S. News and World Report*'s National Liberal Arts Colleges list for 2008. All but one are categorized as Baccalaureate Colleges – Arts & Sciences under the Carnegie 2005 Basic classification scheme. The one exception is categorized as a Master's College and University, but it identifies itself as a liberal arts college. The colleges are located in all eight geographic regions of the U.S. as defined by the National Center for Education Statistics (NCES). Fifteen are located in cities, 18 in towns and suburbs, and one in a rural area, again as defined by NCES. All institutions serve fewer than 3,500 students. The mean graduation rate (total completers within 6 years from the entering cohort adjusted for death, permanent total disability, religious mission, and military or federal service) for these institutions in the academic year 2009 was 81.7%, and the mean undergraduate enrollment in the same year was just under 2,000 students. The 34 institutions collectively enrolled 67,603 undergraduates and awarded 15,526 bachelor's degrees in the 2009 academic year. These figures represent over 15% of undergraduate enrollments and nearly 20% of baccalaureate completions at all 220 of the nations liberal arts colleges according to NCES statistics.

Variables

Two problems present obstacles for determining the degree to which information technology impacts efficiency in higher education. One is the definition of efficiency. Higher education institutions have multiple outputs, the most commonly recognized being learned students, new knowledge, and service to the community. Liberal arts colleges, however, tend to be more focused on graduating well-educated students than on producing new knowledge or serving their civic or professional communities. Narrowing the definition of efficiency for the purposes of this study to the efficiency of a college in graduating students allows for a reasonable comparison of institutions with available data.

Ratings of efficiency using the model provided in Eckles (2010) provide the measure of efficiency in this study. That article rated liberal arts colleges' efficiency using data primarily from the NCES Integrated Postsecondary Education Data System (IPEDS) for the 2006-2007 academic year, with some data coming directly from the USNWR rankings. The exact same variables and techniques are used and are described later, but the data are updated to reflect the 2008-2009 academic year.

The dependent variable from the Eckles (2010) efficiency analysis that is used in the current study is the technical efficiency score, the output of a non-parametric statistical technique known as data envelopment analysis. Data envelopment analysis allows a researcher to identify the institutions that make the most of their available inputs, and then measures all other institutions relative to those top performers. Cost per undergraduate, percent of faculty that are full-time, the percent of entering students in the top 10% of their high school classes, and the 25th percentile SAT score of the entering class were the inputs used in calculating the technical efficiency score. A technical efficiency score is expressed as a percentage and ranges from 0% to 100%. A higher technical efficiency score indicates higher efficiency. A technical efficiency score of 50% would mean that the institution graduated only 50% as many students as would be predicted by the performance of the best institutions with similar levels of input. The actual range of technical efficiency scores in the current sample was 67% to 100%, with a standard deviation of 6.7%.

A second obstacle to determining the impact of information technology on efficiency is a lack of publicly available data on IT management practices in higher education. Two primary sources exist for such data: the EDUCAUSE Core Data Service survey and the Campus Computing Project. Both the Core Data Service and the Campus Computing Project are surveys administered annually for the purpose of sharing data about IT management practices among the groups' members. Neither project typically allows outside researchers access to raw data. The only option available then is for the researcher to collect his or her own data.

In an effort to minimize the burden on institutions who participated in this study, the author simply asked each institution for permission to use the institution's response to some of the Core Data Service questions. The 34 institutions included in the current study both provided written permission and actually had data on every employed variable. The data all reflect the 2006-2007 academic year. This year was chosen because it allows for a time-lag between IT management practices as they existed in the 2006-2007 academic year to result in efficiencies in the 2008-2009 academic year. Prior research has made clear that such a delay is necessary to observe related effects (Ravichandran & Lertwongsatien, 2005; Santhanam & Hartono, 2003; Wade & Hulland, 2004). These papers and others seem to consistently employ a two to three year lag, which justifies the choice for academic years in this study.

The independent variables chosen to represent IT management practices were based on the review of literature concerning IT management in higher education. From among the Core Data Service questions, governance is measured by *IT has standalone strategic plan* (does the IT unit have its own strategic plan, coded 1 for yes and 0 for no), *Rank of top IT officer* (coded as 1 for "Head, Manager, Other", 2 for "Assistant/Associate Director", 3 for "Director, Dean, Executive Director", 4 for "Vice Provost, Assistant/Associate Vice Provost, Vice President, Vice Chancellor", 5 for "Chief Technology Officer", and 6 for "Chief Information Officer"), and *Advisors total* (the total number of groups who the top ranking IT officer formally seeks advice on IT management). Used to represent centralization was *% IT Personnel Centralized* (the percent of the institution's IT personnel who report to the central IT unit). The variables that served as proxies of investment were *Funding Per FTE Student* (dollars expended in the year divided by full-time equivalent student enrollment in the fall), *Total Number of Outsourced Areas* (the total number of IT activities that have been outsourced to a third party), *Student Tech Fee Assessed* (coded as 1 for yes and 0 for no), *Compensation as % of Funding* (for the IT unit), and *% Campus Expenses Spent on IT* (in the year). The concept of security was represented by the variables *IT Security Risk Assessment Performed* (coded as 1 for yes and 0 for no) and *Number of Security Practices* (a simple count of security practices institutions affirmed they have implemented). Finally, the employed measures of alignment were *Top IT Officer Sits on Cabinet* (coded as 1 for yes and 0 for no) and *Institution Strategic Plan Includes IT* (coded as 1 for yes and 0 for no). Descriptive statistics of all variables used are presented in Table 2 below.

Because Eckles (2010) observed that institution size was significantly correlated with efficiency, total fall undergraduate enrollment in 2009 is included as a control in the current model.

Table 2

Descriptive Statistics

Variable	Type	N	Min	Max	M	SD
Technical Efficiency score	scale	34	0.67	1	0.95	0.07
Governance						
IT has standalone strategic plan	nominal	34	0	1	0.68	0.47
Rank of top IT officer	ordinal	34	1	6	3.88	1.27
Advisors total	ordinal	34	0	5	2.71	1.19
Investment						
% Campus Expenses Spent on IT	scale	34	0.03	0.09	0.05	0.01
Funding Per FTE Student	scale	34	597.96	2321.58	1425.85	489.37
Compensation as % of Funding	scale	34	0.34	0.76	0.50	0.10
Total Number of Outsourced Areas	ordinal	34	0	5	1.29	1.49
Student tech fee assessed	nominal	34	0	1	0.15	0.36
Centralization						
% IT Personnel Centralized	scale	34	0.74	1	0.86	0.07
Security						
IT security risk assessment	nominal	34	0	1	0.53	0.51
Number of security practices	ordinal	34	5	11	8.06	1.57
Alignment/Strategic Planning						
Top IT officer sits on cabinet	nominal	34	0	1	0.59	0.50
Institution strat. plan includes IT	nominal	34	0	1	0.79	0.41
Control						
Fall 2009 Enrollment	scale	34	763	3230	1988.32	568.48

Analysis

Eckles (2010) used an economic technique known as production frontier analysis to study the efficiency of outcomes via graduation rates for elite liberal arts colleges in the United States. Specifically, he employed the data envelopment analysis (DEA) model developed initially by Archibald and Feldman (2008). DEA is a non-parametric statistical technique that allows the researcher to identify the institutions that make the most of their available inputs and then measure all other institutions relative to those top performers. In lay terms, the idea behind frontier analysis is to seek a residual not unlike more common linear regression models. Where frontier analysis differs is that instead of seeking a residual compared to the average performance of the sample (i.e., the best-fit line), it seeks a residual compared to the very best performers at any given level of inputs. Those very best performers are said to be technically efficient, and have a residual of zero. The non-zero residual of the remaining institutions allows the researcher to construct a measure of efficiency relative to those top performers. Eckles (2010) used a DEA model with graduation rate as the output or dependent variable, and the input or independent variables included cost per undergraduate, percent of faculty who are full-time, 25th percentile SAT score of the entering class, and the percent of the entering class who were in the top 10% of their high school classes.

Because the answer to the research question requires an investigation of the relationship between a single dependent variable (technical efficiency score) and multiple independent variables, ordinary least squares (OLS) multiple linear regression was selected. Multiple linear regression allows a researcher first to determine if a relationship exists between the dependent and independent variables, second to determine which individual independent variables make a significant contribution to the variance in the dependent variable, and finally to determine the order of importance of the individual independent variables that do make a contribution. OLS is chosen as the method for computing least squares because it is very familiar to a wide audience. Here OLS multiple linear regression was used to determine whether the IT management variables explained a significant portion of the variation in the technical efficiency scores.

The assumptions underlying ordinary least squares regression begin with the assumption that there is a linear relationship between the independent and dependent variables. The hypothesis tested in this study, that superior IT management practices result in increasing levels of institutional efficiency, takes this assumption for granted, though it will be tested by inspecting a scatter plot of standardized residuals versus predicted values. OLS also assumes that the variances of the error terms are constant and that they are normally distributed. The standardized residuals versus predicted values scatter plot will help determine if the error term variance is constant. Whether the error variances are normally distributed will be tested by inspecting a histogram of the standardized residuals, comparing it to a normal distribution curve (Stevens, 2002). A final assumption is that the independent variables are not collinear. This assumption is tested by inspecting the variance inflation factor (VIF) of each variable in the model.

Nominal variables were dummy coded; all were yes-no variables with *yes* coded as one and *no* as zero.

An attempt was made to condense the individual IT management scores into scales. However, reliability analysis for scales of governance, investment, security, and alignment constructed from the available variables indicated low levels of internal consistency based on Cronbach Alpha scores (governance = 0.268, investment < 0.001, security = 0.312, alignment = 0.198). The decision to treat these variables in groups is based then only on the literature and not on the quantitative characteristics of the data.

Not only does the literature suggest these variables be evaluated in groups, but the review of literature concerning IT management in higher education also suggests a hierarchy among the five groups of variables (with Governance variables as causes, Investment and Centralization variables as mediators, and Security and Alignment variables as effects). The literature therefore suggests that the Governance variables might have the most impact on efficiency, then Investment, then Centralization, then Security, and finally Alignment. Based on this reading, the variables are entered into the regression in five blocks in order from driver to effects. Fall 2009 enrollment, a control variable, will precede these five blocks.

In evaluating whether the model explains a significant portion of the variance, an alpha of 0.15 is used. This decision is based on the small sample size and a reasonable expectation that the effects of information technology on efficiency, if any, are muted due to the relatively small proportion of an institution's budget typically devoted to information technology (the mean for sampled institutions was 5%). Because of the small number of institutional observations and the relatively large number of predictor variables, the coefficient of determination (R^2) value will be adjusted to provide a more conservative estimate of the amount of variation explained (Hinkle, Wiersma, & Jurs, 2003).

Chapter 4

Findings

The technical efficiency scores for the 34 sampled colleges were calculated using the computer programDEAP 2.1 (Coelli, 1996). The analysis was output oriented assuming variable returns to scale just as in Eckles (2010). Thirteen of the institutions (38%) were technically efficient. The complete results of the DEA including technical efficiency scores, input slacks, identified peers, and peer weights is included as Appendix A.

The fact that 38% of the institutions were operating at a technically efficient level is of no particular significance. One of the features of DEA is that no limit exists to the proportion of the sample that can be technically efficient. The 13 technically efficient institutions in this sample were exhibiting the best demonstrated performance for their respective distinct levels of inputs.

The technical efficiency scores ranged from 0.67 to 1, with an average of 0.95, median of 0.97, and a standard deviation of 0.07. The Excel "skew" function provided a score of -2.53 for the distribution using the function

$$\frac{n}{(n-1)(n-2)}\sum\left(\frac{x_i-\bar{x}}{s}\right)^3$$

The skewness score is six standard errors of skewness away from zero, indicating a significantly negatively skewed distribution (Brown, 1997). It is worth noting, though, that Reed College with the lowest efficiency score at 67% makes that variance larger than it otherwise would be. The next lowest efficiency score was 85%. Whether Reed was truly an outlier is investigated in the regression results.

The fact that the mean technical efficiency score was 0.95 means that on average the sampled institutions were operating at 95% efficiency. The standard deviation of 7% means that there was moderate variance in the levels of efficiency.

The OLS multiple linear regression was executed using PASW Statistics 17.0. No collinearity problems were observed in any of the regression models; all variables had Variance Inflation Factors less than 10. Figure 3 shows a scatter plot of the standardized residuals versus the predicted values. The chart shows no evidence of curvilinearity or of non-constant variance. Figure 4 shows a histogram of the standardized residuals in comparison to a normal distribution curve. The residuals are reasonably normally distributed. These two charts affirm that all assumptions made by the OLS are met.

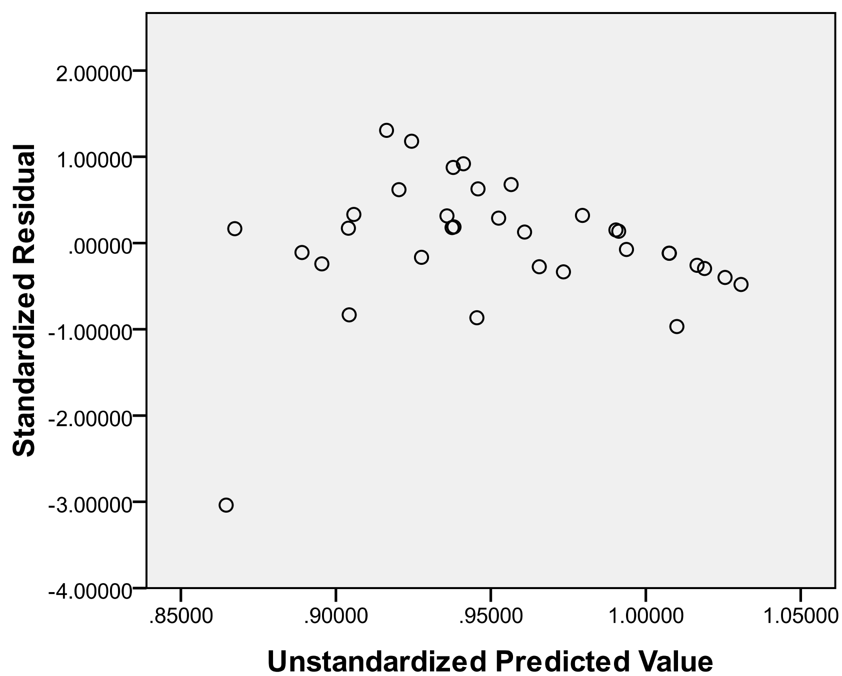

Figure 3. Standardized residuals versus predicted values

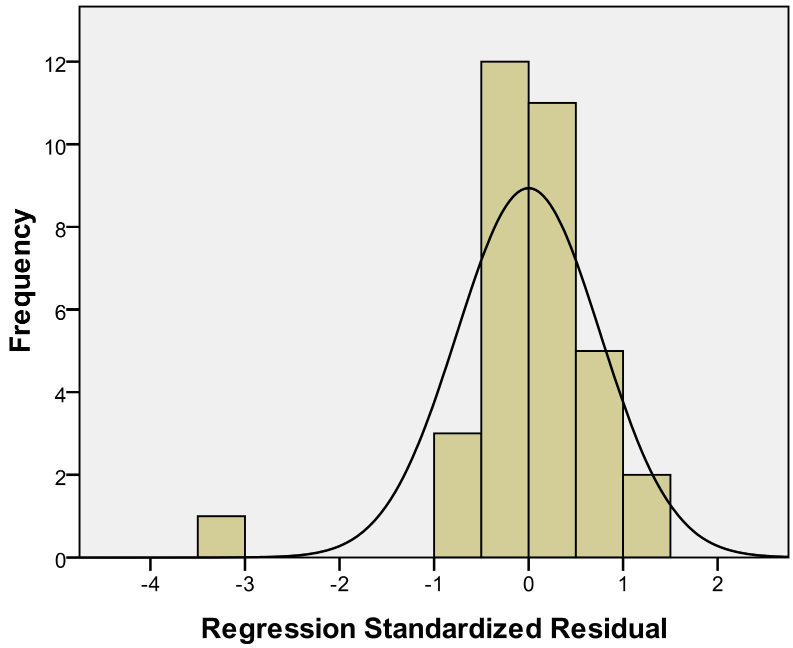

Figure 4. Histogram of standardized residuals

The two charts, though, do again highlight the potential outlier in the dataset, Reed College. The standardized residual for Reed's case was -3.04. The potential outlier does not, however, appear to have unduly influenced the results of the model. The Mahalanobis distance (which is a measure of a point's deviance from the center of the data cloud) was only 6.60, far less than the critical value of 16.40 (based on $k = 4$, $n = 35$, $\alpha = 0.01$) and therefore not significant (Stevens, 2002). Likewise, the Cook's distance was only 0.238, where values greater than 1.0 suggest undue influence (Stevens, 2002). Both the Mahalanobis statistic and the Cook statistic suggest that the apparent outlier is in fact relatively close to the other data points. Without statistical evidence that the case may have influenced the results and without any clear substantive reason to remove Reed from the dataset, the case was retained and the regression was not re-run.

The first research question was whether there exists a statistically significant relationship between the dependent variable, technical efficiency (representing efficiency at graduating students), and the set of fourteen independent variables representing information technology management practices. The regression models described in Table 3 address that question. The first model, which regressed efficiency against only fall enrollment, was not significant at the 0.15 level (p = 0.204). The second model, which included the fall enrollment and the governance variables, was significant (p = 0.089). None of the other models, each of which in turn added to the previous model blocks of variables regarding investment, centralization, security, and alignment, were significant at the 0.15 level. As measured by the adjusted R^2, model 2 containing both the fall enrollment and governance variables explained about 13% of the variance in the technical efficiency scores.

Table 3

Regression results, dependent variable = efficiency score

Model (Ind. Vars)		Sum of Squares	*df*	Mean Square	*F*	*p*
1 (Fall enrollment)	Regression	.007	1	.007	1.683	.204
	Residual	.140	32	.004		
	Total	.147	33			
2 (Fall enrollment plus governance variables)	Regression	.035	4	.009	2.244	.089
	Residual	.113	29	.004		
	Total	.147	33			
3 (Model 2 variables plus investment variables)	Regression	.054	9	.006	1.526	.195
	Residual	.094	24	.004		
	Total	.147	33			
4 (Model 3 variables plus centralization variables)	Regression	.058	10	.006	1.472	.212
	Residual	.090	23	.004		
	Total	.147	33			
5 (Model 4 variables plus security variables)	Regression	.063	12	.005	1.307	.285
	Residual	.084	21	.004		
	Total	.147	33			
6 (Model 5 variables plus alignment variables)	Regression	.069	14	.005	1.209	.344
	Residual	.078	19	.004		
	Total	.147	33			

The equation for model 2 is as follows:

Technical efficiency = 1.008 + 0.000(Fall 2009 enrollment) – 0.012(IT has standalone strategic plan) – 0.018(Rank of top IT officer) – 0.010(Advisors total)

In the presence of other variables in model 2, only the rank of the top IT officer had significant contribution to the variance in technical efficiency score (t = -2.019, p = 0.053). Interestingly, the coefficient for the variable is negative, indicating that schools with lower ranking top IT officers are more efficient. The effect, while not large, is not negligible; for each step lower in rank (e.g., from Vice President to Director), the schools on average exhibited 1.8% higher efficiency. The average rank among sampled schools was, again, 3.88, where the value “Vice Provost, Assistant/Associate Vice Provost, Vice President, Vice Chancellor” was coded as 4.

Chapter 5

Conclusion

Introduction

One issue must be addressed before making conclusions based on the statistical findings. Do the results suggest a causal link between the rank of the top IT officer and efficiency in graduating students, or are the two merely related? The case against a causal interpretation is that the statistical tests employed do not have the ability by themselves to identify causation; they can only identify correlation. In order to assume that the rank of the IT officer caused the efficiency of graduating students, one must accept that a direct cause-and-effect relationship between management practices and graduation rates.

On the other hand, though, the temporal element of the analysis suggests a causal link could exist. The IT management practices, including the rank of the top IT officer, are measured at a point in time three years prior to the point when efficiency in graduating students is measured. The implication is that past management practices would have a direct impact on future efficiency. Further, the theoretical foundation of this study, the resource based view of the firm, posits that the output of an institution (graduated students) is the result of inputs (students, faculty, and money) acted upon by the administrative framework that includes information technology management. In other words, the theory states that differences in management practices will result in different outputs with the same inputs, causing differences in efficiency.

Based on the temporal element of the analysis and the theoretical framework, I will interpret the findings of this study under the assumption that a causal link exists between IT management practices and efficiency at graduating students.

Conclusions

To begin forming an interpretation of the findings, it may be useful to describe the observations in narrative form. The first regression model, which regressed efficiency against only Fall 2009 enrollment, sought to determine is the existence of a significant relationship between the size of the institution as measured by its student body and the institution's efficiency at graduating those students. The reason this step was important is that it helps isolate the impact of IT management on efficiency . Efficiency comes from multiple sources, one of which is the scale of operations (hence the term *economies of scale*) (Utterback, 1996). By showing that there was no statistical relationship between efficiency and scale (as measured by student enrollment), one potential source of efficiency was eliminated. The first model with only enrollment as an independent variable was not significant, suggesting that economies of scale are not at play among the studied institutions. In this study, being bigger did not mean an institution was more efficient.

The second regression model added in a block of governance variables to the regression. Those variables included the rank of the top IT officer, whether or not IT has a standalone strategic plan, and the number of advisers outside IT (such as trustees, faculty committees, etc.) employed by the top IT officer. This time, the model did explain a significant portion of the variance in efficiency among the institutions studied. More specifically, the model explained (conservatively) approximately 13% of the variance. As described previously in the methodology section, the reasons for the use of a conservative estimate of the model's explanatory power were the small number of institutional observations relative to the number of predictor variables.

None of the other regression models, which in turn added variables for investment, centralization, security, and alignment, explained a significant portion of the variance. That is actually a very interesting finding. It is not the case that these models did not add to the explanatory power of the governance variables; they actually eliminated the ability of the model to explain a significant portion of the variance. Issues of investment, centralization, security, and alignment were all noise. They are all secondary to the issue of governance in explaining variance in efficiency of graduating students. This makes sense because the literature of higher education IT management suggests that governance is the driving force in IT management, and that investment, centralization, security, and alignment all follow as consequences of or are influenced by governance decisions. The literature and the statistical findings taken together lead to the major conclusion of this study: differences in governance of IT cause differences in efficiency of graduating students for the sampled institutions. One may go a step further and conclude that differences in investment, centralization, security, and alignment of IT are likely consequences of differences in governance and do not appear to have a direct impact on differences in efficiency of graduating students.

What seems to be clear by looking at the technically inefficient institutions as a group is that what are thought of in the literature as positive markers of governance (a CIO at the helm, a standalone strategic plan for IT, and numerous advisors) come with some sort of cost, either in terms of money or organizational friction. More to the point, those costs do not pay off sufficiently in terms of graduation rates. Whereas 67.6% of all the institutions had a strategic plan for IT, such is the case for only 61.5% of the 13 efficient colleges. Vice president is the modal title of the top IT officer among all institutions sampled (observed in over 25% of the cases), but among the efficient institutions the title of director is the mode, observed in over 60% of the cases). The number of advisors to IT for all sampled institutions was 2.71, but for the efficient colleges it was just 2.31.

In the regression model that included enrollment and governance variables, the only variable that by itself had significant impact was the rank of the top IT officer. Perhaps counter-intuitively given the literature reviewed earlier, the coefficient of that variable was negative. That means that the higher the rank of the top IT officer, the less efficient the institution tends to be. The average rank among the sampled schools was something along the lines of vice-president. The implications of the result beg the question, "to attain greater efficiency, should institutions demote their top IT officer to a lower rank?"

That is a difficult question to answer. A couple of points are worth keeping in mind when evaluating the question. The first is that the rank of the top IT officer was significant *in the presence of the other variables in the model*. The rank of the top IT officer may not be interpreted in isolation; even though it alone was significant, its significance exists only in the context of enrollment, the IT strategic plan, and the advisers to IT. It may be that the rank of the top IT officer was the only variable significant because it is the only one that can be related directly to a specific dollar figure. The higher the rank of the IT officer, the more the officer is going to be paid and the more likely it is that the officer can obtain greater funds for IT. If the higher paid officer does not result in a higher graduation rate, then the institution has reduced its efficiency by spending more for the same result. The question, though, is whether an institution can have a strong and effective strategic plan and can have adequate advisors in place without having a sufficiently high ranking IT officer. That question is not addressed in these data.

Of course, one might rightly argue that talk of changing the title of the top IT officer in a quest for efficiency is missing the point altogether. A more substantive approach to the interpretation of the finding is to consider what benefits the efficient institutions might be obtaining by having a lower-ranked top IT officer. While literature suggests that having a CIO with a seat at the president's table is the ideal scenario for universities, might there be greater rewards to be reaped at smaller liberal arts colleges by having the top IT officer be nearer the front lines?

The CIO of a liberal arts college included in this study suggested a rather simple explanation for what might be otherwise interpreted as surprising findings. His take was that the higher your rank, the more money you spend. At institutions with a high ranking CIO who has maybe five peers on the president's staff, competition for funding is relatively tame. At institutions with a lower ranking top IT officer with maybe 25 peers at the director level, the competition for funding is much more fierce. The spending level is, in his opinion, likely correlated with access to the top decision makers. Consequently, those institutions with lower ranking top IT officers are doing more with less and are more efficient. Those institutions with higher ranking top IT officers are by extension doing more with more (R. Johnson, personal communication, February 15, 2011).

Another potential reason for the negative relationship between efficiency and the rank of the top IT officer is related to power and decision making. If rank is a proxy of power in these institutions, then a higher ranking CIO has more power relative to other stakeholders than a lower ranking top IT officer. Other stakeholders include those who actually do the work that leads to graduating students: faculty, students, and direct support staff. Increased relative power leads to increased influence in decision making (Salancik & Pfeffer, 1974). The question one might raise, then, is who makes better decisions on IT management: those closer to the work or those with a broader view.

The broad view may be more critical at larger institutions with broader missions that include service and research in addition to graduating students. This study evaluated only the outcome of graduation rates. If the value of a chief IT officer with a broad view is realized primarily in other outcomes of a college or university, then it is unsurprising that higher-ranking IT officers did not contribute to efficiency in this study. In institutions studied here, when the top IT officer is lower ranked and therefore has lower power relative to the stakeholders close to the work, one tends to observe increased efficiency. Those stakeholders have more relative power and therefore more influence on the decision making regarding IT management. Taken together this line of reasoning suggests that those closer to the work are making better decisions, or at least more efficient ones.

Huber and McDaniel (1986) offered guidelines that have become the foundation for much of the recent research on decision making in organizations. First among their guidelines was to assign decision making authority to the level in the organizational hierarchy that minimizes the costs associated with a lack of information about the situation on the ground and a lack of information about the organization's overall direction and policy. It is possible that institutions who have placed IT operations in the hands of a highly ranked officer are overestimating the costs of a lack of information about the organization's overall direction and policy, are underestimating the costs of a lack of information about the situation on the ground, or both. Because of the relatively small size of these institutions, it could be that the mission and direction of the whole institution is well-understood by all, making the more important aspect of decision making be an awareness of the situation on the ground. Such a scenario would demand a lower-ranked top IT officer for the best decision making, presumably leading to higher efficiency.

Recommendations

The results of this study and the subsequent conclusions lead to a number of recommendations.

For top liberal arts colleges, maximizing the positive impact of IT management practices on the efficiency of graduating students requires a focus on issues of IT governance. Institutions such as those studied here should review how they have structured their IT organization and the decision-making authority related to IT management practices. In light of the finding that lower-ranked top IT officers are found at more efficient institutions, it is important for these schools to evaluate information gaps. Specifically it is important for these schools to determine how aware the top IT officer is of operational details, not just within IT but within the stakeholder groups including clients in the college's functional areas, VPs of those areas, students, and faculty.

It is not enough, though, to simply analyze the information gap. Schools that seek improved efficiency must take steps to narrow that gap. It may be wise for the top IT officer to spend some time teaching a class at the institution to gain a first-hand understanding of how technology impacts students and faculty. It may be likewise beneficial for the officer to work directly with associate directors, coordinators, and other professionals throughout the institution to understand their work.

Perhaps most importantly, though, it is critical that the institutions work to develop an institutional culture that does not inhibit the upward flow of information to the top IT officer. Part of the issue is structural. Bolman and Deal (2003) describe structural dilemmas that confront organizations including colleges; one dilemma is reducing information gaps while minimizing overlaps in functions. It may be tempting to focus more on minimizing the overlaps in a question for greater efficiency. But, if doing so results in information gaps, then any gains from reducing overlaps will be immediately lost. Further, additional layers in organizational hierarchy that may attend a higher ranked top IT officer cause communication to become slower and more cumbersome. Consequently, the structure of the IT department, of stakeholders' departments, and especially the relationships among them matter.

Another part of the issue of information flow up to the top IT officer is cultural (Bolman & Deal, 2003). If the top IT officer is perceived as one who reacts poorly to negative feedback, then constituents who could bridge information gaps quickly become trained to avoid providing bad news to the boss. In illustrating the importance of timely and accurate feedback, Peter Senge (2006) asked readers to image the system of getting the water temperature right in the bath tub. The bather turns on the hot water and immediately feels the temperature, which is too cold, so he turns the hot water on higher. Soon, though, the water becomes far too hot and the cold water is turned on. Immediately feeling the temperature the water is still too hot, so the cold is turned on higher. Soon though it is apparent the bather overshot the mark. Delayed feedback (the change in water temperature that results from turning a knob) resulted in the bather making bad decisions. If timely and accurate feedback is critical in such a simple process, how much more important is it, then, in governing an IT operation? It is critical for liberal arts colleges to promote a culture in which honest feedback is rewarded, thereby narrowing the information gap and making higher ranked top IT officers better decision makers.

In addition to institutions evaluating their structure and culture, the conclusions drawn here should lead individual practitioners to evaluate their roles in their institutions. Regardless of institutional structure or culture, it behooves IT managers to be aware of what gaps may exist in their knowledge of the institution. They need to know what they do not know. They need to consider how timely and accurate is the feedback they do receive. Additionally, IT managers should seek to determine if feedback is being withheld for any reason. Implementing these recommendations will be difficult for even competent leaders. Doing so requires a critical self-examination, a keen sense of self-awareness, and the ability to set aside defensiveness. Managers who are successful in implementing this recommendation will have to be open to discovering that feedback is being withheld because people believe (fairly or unfairly) that bad news is punished. They must also have the strength to make changes to address such problems.

Finally, researchers studying the chief information officer role in higher education may need to focus on both sides of the information gap. To date the focus of research on that role has implicitly placed maximum value on the cost of the information gap with regard to the institution's mission and direction. This study, however, suggests that the cost of the information gap with regard to operational details has been underrated. Recommendations that the CIO always have a seat on the president's cabinet and be a vice-president-level officer may not be appropriate for all types of institutions.

Future Research

While this study has general implications for research into the CIO role in higher education, much work remains specifically in the area of IT's impact on and value in achieving institutional and student outcomes. Three primary threads of research may emerge from the platform of this dissertation. The first thread is one of breadth, applying similar techniques to other sectors of higher education. The second thread is one of length, investigating changes over time. The third thread is one of depth, seeking more meaning of the impact of IT with more specific outcomes and practices.

Initially it may make sense to first pursue an increased breadth of institutions as the focus of studies with methodologies similar to the current study. For-profit higher education has exploded in the past five years, with much of the sector's growth accorded to online learning and other technological practices. According to data from IPEDS, community colleges and other public two-year institutions continue to enroll the greatest share of students in higher education in the United States yet have the lowest graduation rates of any sector. Investigations in the two-year sector could have generalizability to improve educational practice for the largest number of students. Special purpose institutions including single gender institutions, historically black colleges, tribal colleges, and discipline-specific colleges all may benefit from lessons regarding IT management practices but must be studied with like schools.

Another direction for future research is to further investigate the time dimension in the impact of IT management practices on graduation rate efficiency. The literature suggested a lag of two to three years between IT management practice and effect on graduation rate. A useful investigation would be whether the lag is longer or shorter. Along similar lines, the findings could be strengthened by evaluating multiple years of both IT management practices and graduation rates. Such a multi-year approach could take the form of a cross-sectional study or a longitudinal study. A cross-sectional design might identify years with changes in IT management practices and then seek corresponding changes in efficiency. A longitudinal design might look at the practices of a few institutions over several years and match the observations with the changes in graduation rates over a similar period of time.

The most interesting line of future research, though, will dig deeper into the questions of “why?” Why does governance matter? Among the possible explanations presented in this study for the finding that lower-ranked top IT officers are correlated with higher efficiency, which explanations (if any) resonate with the top IT officers at those high efficiency institutions? This deep thread of research can take several forms.

One form is investigating at a lower unit of analysis. Rather than studying graduation rate efficiency at the institutional level and general IT management practices, future research might investigate specific cognitive development outcomes in students and whether they relate to specific technological practices such as learning management systems, electronic portfolios, self-service degree analysis, etc. Measures for cognitive development exist, and data on specific practices are likely easy to collect. The challenge will be establishing the link between outcomes and practices.

Another form is studying the issue using qualitative techniques rather than a quantitative approach such as the one employed in the current study. Qualitative methods would allow the researcher to seek out the meaning of the quantitative findings. Case studies of highly efficient colleges, interviews with stakeholders at institutions with high and low ranking top IT officers, and similar techniques would add color and texture to the black and white outline presented in this dissertation.

Summary

The original query that launched this study was whether IT management practices have a discernible impact on the ability of top liberal arts colleges to graduate students. To address that question, the institutions were viewed as bundles of resources (student ability, faculty, money, buildings, etc.) processed by an administrative framework (which includes information technology) to produce graduated students. In an attempt to put the sampled institutions on a level playing field in terms of available resources, raw graduation rates were not the dependent variable of the analysis. Rather, the efficiency with which the colleges graduate students given the available resources became the target for analysis. MIS and higher education literature provided both a conceptual foundation and the source of both variables related to IT management practices and their order of entry into the analysis.

Upon analyzing the data, evidence was found that supported the hypothesis that there is a relationship between graduation efficiency and variables measuring the governance of IT. Surprisingly, the evidence pointed to a negative relationship. It turned out that the more efficient institutions tended to have lower ranked top IT officers. Several potential meanings of this finding were discussed. Ultimately the finding raises questions about the top IT officer role and the relative costs of a lack of information regarding the overall mission and direction of the institution and the operational situation at the institution.

Recommendations for institutions included evaluating the structure and culture of the institution as a means of understanding those information gaps and their costs. Implications for individual practitioners were also discussed, with a similar recommendation for reflection and self-evaluation. Finally, the study recommended that a shift in focus in higher education CIO research may be in order. More specific to the original query though, three lines of future research were identified. These threads will attempt to generate broader, longer, and deeper knowledge on the impact of IT management practices on student outcomes.

While scholars have debated both within and outside higher education as to whether information technology matters, I for one have become convinced that it does matter. Our ability to graduate students is impacted, though admittedly only moderately, by the choices we make in governing information technology at top liberal arts colleges. Those impacts, however, are not always obvious either in scale or direction.

References

Acemoglue, D., Aghion, P., Lelarge, C., Van Reenan, J., & Zilibotti, F. (2007). Technology, information, and the decentralization of the firm. *Quarterly Journal of Economics*, *122*(4), 1759-1800.

Albrecht, B., Bender, B., Katz, R. N., Pirani, J. A., Salaway, G., Sitko, T. D., & Voloudakis, J. (2004). *Information technology alignment in higher education* (Research Study No. 3). Boulder, CO: EDUCAUSE Center for Applied Research.

Anjard, R. P. (1995). Management and Planning Tools. *Training for Quality, (3)*2, 34-37.

Archibald, R. B., & Feldman, D. H. (2008). Graduation rates and accountability: Regressions versus production frontiers. *Research in Higher Education, 49*(1), 80-106.

Barney, J. B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management, 17*, 99-120.

Barney, J. B., Wright, M., & Ketchen, D. J. (2001). The resource-based view of the firm: Ten years after 1991. *Journal of Management, 27*, 625-641.

Barone, C. A., & P. R. Hagner (Eds.) *Technology-enhanced teaching and learning*. EDUCAUSE Leadership Strategies No. 5. San Francisco, CA: Jossey-Bass, 2001.

Battin, P. (1989). New ways of thinking about financing information technology. In B. L. Hawkins (Ed.), *Organizing and managing information resources on campus* (pp. 369-383). McKinney, TX: Academic Computing Publications.

Bharadwaj, A. S. (2000). A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. *MIS Quarterly, 24*(1), 169-196.

Bolman, L. G., & Deal, T. (2003). *Reframing organizations: Artistry, choice, and leadership*. San Francisco, CA: Jossey-Bass.

Brown, J. D. (1997). Skewness and kurtosis. *Shiken: JALT Testing & Evaluation SIG Newsletter, 1*(1), 20-23.

Brynjolfsson, E. (1996). The contribution of information technology to consumer welfare. *Information Systems Research, 7*(3), 281-300.

Carr, N. G. (2004). IT Doesn't Matter. *IEEE Engineering Management Review, 32*(1), 24.

Cavalier, J. C. (2002). The forgotten question in information technology strategic planning. *Planning for Higher Education, 31*(1), 5-14.

Chan, Y. E. (2000). IT Value: The great divide between qualitative and quantitative and individual and organizational measures. *Journal of Management Information Systems, 16*(4), 225-261.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2*(6), 429-444.

Coelli, T. (1996). A guide to DEAP version 2.1: a data envelopment analysis (computer) program. CEPA Working Paper 96/08.

Conner, K. R. (1991). A Historical comparison of resource-based theory and five schools of thought within industrial organization economics: Do we have a new theory of the firm? *Journal of Management, 17*(1), 121-154.

Crowston, K., & Treacy, M. F. (1986). Assessing the impact of information technology on enterprise level performance. *Seventh Annual International Conference on Information Systems*, San Diego, CA.

Day, G. S. (1994). The capabilities of market-driven organizations. *Journal of Marketing, 58*(4), 37-52.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research, 3*(1), 60-95.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems, 19*(4), 9-30.

Dhillon, J. K. (2001). Challenges and strategies for improving the quality of information in a university setting: A case study. *Total Quality Management, 12*(2), 167-177.

Dill, D. (1999). Academic accountability and university adaptation: The architecture of an academic learning organization. *Higher Education, 38*(2), 127-154.

Doherty, N. F., & Terry, M. (2009). The role of IS capabilities in delivery sustainable improvements to competitive positioning. *Journal of Strategic Information Systems, 18*(2), 100-116.

Doty, D., Glick, H., & Huber, P. (1993). Fit, Equifinallity, and Organizational Effectiveness: A Test of Two Configurational Theories. *Academy of Management Journal, 36*(6), 1196-1250.

Duderstadt, J. J. (1999). Can colleges and universities survive in the information age? In R. N. Katz (Ed.), *Dancing with the devil: Information technology and the new* *competition in higher education* (pp. 1-25). San Francisco, CA: Jossey-Bass Publishers.

Eckles, J. (2010). Evaluating the efficiency of top liberal arts colleges. *Research in Higher Education, 51*(3), 266-293.

Farrington, G. C. (1999). The new technologies and the future of residential undergraduate education. In R. N. Katz (Ed.), *Dancing with the devil: Information technology and the new competition in higher education* (pp. 73-94). San Francisco, CA: Jossey-Bass Publishers.

Gonick, L. (2009). The wiki way and university leadership. *The Chronicle of Higher Education*, February 4, 2009. Retrieved August 21, 2009 from http://chronicle.com/blogPost/Lev-Gonick-More-on-What-Wi/4515/

Graves, W. H. (2001). Virtual operations: Challenges for traditional higher education. *EDUCAUSE Review, 36*(2), 46-56.

Griffiths, P., & Remenyi, D. (2003). Information technology in financial services: A model for value creation. *Electronic Journal of Information Systems Evaluation, 6*(2), 107-116.

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). *Applied Statistics for the Behavioral Sciences*. Boston: Houghton Mifflin Company.

Huang, S. M., Ou, C. S., Chen, C. M., & Lin, B. (2006). An empirical study of relationship between IT investment and firm performance: A resource-based perspective. *European Journal of Operations Research, 173*(3), 984-999.

Huber, G. P., & McDaniel, R. R. (1986). The decision-making paradigm of organizational design. *Management Science, 32*(5), 572-589.

Iivari, J. (2005). An empirical test of the DeLone-McLean Model of Information System Success. *ACM SIGMIS Database*, *36*(2), 8-27.

Johnson, R. A., Mitrano, T., & Vernon, R. D. (2003). Meeting the cybersecurity challenge. In P. A. McClure (Ed.), *Organizing and managing information resources on your campus* (pp. 93-111). San Francisco, CA: Jossey-Bass.

Katz, R. N. (1999). Competitive strategies for higher education in the information age. In R. N. Katz (Ed.), *Dancing with the devil: Information technology and the new competition in higher education* (pp. 27-49). San Francisco, CA: Jossey-Bass Publishers.

Kvavik, R. B., & Voloudakis, J. (2006). *Safeguarding the tower: IT security in higher education 2006* (Research Study No. 6). Boulder, CO: EDUCAUSE Center for Applied Research.

Luftman, J. N., Lewis, P.R., & Oldach, S. H. (1993). Transforming the enterprise: The alignment of business and information technology strategies. *IBM Systems Journal*, *32*(1), 198-221.

McClellan, G. S., Cruz, G. A., Metcalfe, A. S., & Wagoner, R. L. (2006). Toward technological bloat and academic technocracy: The information age and higher education. In A. S. Metcalfe (Ed.), *Knowledge management and higher education: A critical analysis* (pp. 63-29). Hershey, PA: Information Science Publishing.

McRobbie, M. A. (2007). The Place of information technology in planning for innovation. *EDUCAUSE Review*, November/December 2007, 12-13.

Melville, N., Kraemer, K., & Gurbaxani, V. (2004). Information technology and organizational performance: An integrative model of IT business value. *MIS Quarterly, 28*(2), 283-322.

Mittal, N., & Nault, B. R. (2009). Investments in information technology: Indirect effects and information technology intensity. *Information Systems Research, 20*(1), 140-154.

Neal, J. G., & McClure, P. A. (2003). Organizing information resources for effective management. In P. A. McClure (Ed.), *Organizing and managing information resources on your campus* (pp. 29-44). San Francisco, CA: Jossey-Bass.

Nelson, M.R. (2003). *The CIO in Higher Education: Leadership, Competencies, Effectiveness* (Research Bulletin No. 22). Boulder, CO: EDUCAUSE Center for Applied Research.

O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer, and spinoff performance of U.S. universities. *Research Policy, 34*(7), 994-1009.

Oblinger, D. G., & Hawkins, B. L. (2006). The myth about no significant difference. *EDUCAUSE Review, 41*(6), 14-15.

Oh, W., & Pinsonneault, A. (2007). On the assessment of the strategic value of information technologies: Conceptual and analytical approaches. *MIS Quarterly, 31(*2), 239-265.

Penrod, J. I. (2005). *Reflections on a Career as a Four-Time CIO* (Research Bulletin No. 21). Boulder, CO: EDUCAUSE Center for Applied Research.

Penrod, J. I., & Harbor, A. F. (2000). Designing and implementing a learning organization-oriented information technology planning and management process. In L. A. Petrides (Ed.), *Case studies on information technology in higher education: Implications for policy and practice* (pp. 7-19). Hershey, PA: Idea Group Publishing.

Penrose, E. (1959). *The Theory of the Growth of the Firm*. Basil Blackwell: London.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal, 14*, 179-191.

Peteraf, M. A., & Barney, J. B. (2003). Unraveling the resource-based tangle. *Managerial & Decision Economics, 24*(4), 309-323.

Powers, J. B., & McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. *Journal of Business Venturing, 20*(3), 291-311.

Radhakrishnan, A., Zu, X., & Grover, V. (2008). A process-oriented perspective on differential business value creation by information technology: An empirical investigation. *Omega, 36*(6), 1105-1125.

Rainer, R. K., Turban, E., & Potter, R. E. (2007). *Introduction to information systems: Supporting and transforming business.* Hoboken, NJ: John Wiley & Sons.

Sabherwal, R., & Kirs, P. (1994). The alignment between organizational critical success factors and information technology capability in academic institutions. *Decision Sciences, 25*(2), 301-330.

Salancik, G. R., & Pfeffer, J. (1974). The bases and use of power in organizational decision making: The case of a university. *Administrative Science Quarterly, 19*(4), 453-473.

Sambamurthy, V., & Zmud, R. W. (1999). Arrangements for information technology governance: A theory of multiple contingencies. *MIS Quarterly, 23*(2), 261-290.

Santhanam, R., & Hartono, E. (2003). Issues in linking information technology capability to firm performance. *MIS Quarterly, 27*(1), 125-153.

Shpilberg, D., Berez, D., Puryear, R., & Shah, S. (2007). Avoiding the alignment trap in information technology. *MIT Sloan Management Review, 49*, 1, 51-58.

Stemmer, J. K. (2007). The perception of effectiveness of merged information services organizations. *Reference Sciences Review, 35*(3), 344-359.

Stevens, J. P. (2002). *Applied Multivariate Statistics for the Social Sciences* (4th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Stoel, M. D., & Muhanna, W. A. (2009). IT capabilities and firm performance: A contingency analysis of the role of industry and IT capability type. *Information & Management, 46*(3), 181-189.

Thatcher, M. E., & Oliver, J. R. (2001). The impact of technology investments on a firm's production efficiency, product quality, and productivity. *Journal of Management Information Systems, 18*(2), 17-45.

Wade, M., & Hulland, J. (2004). The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS Quarterly, 28*(1), 107-142.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2). 171-180.

Zajac, E. J., & Kraatz, M. S. (1993). A diametric forces model of strategic change: Assessing the antecedents and consequences of restructuring in the higher education industry. *Strategic Management Journal*, *14*(S1), 83-102.

Appendix A. Data Envelopment Analysis Results

Table A1

Data Envelopment Analysis Inputs and Efficiency Scores

College	grad rate	cost per undergraduate	% ft fac	SAT 25th	% fresh top 10%	VRS TE
1	57.4	$ 71,903.07	70.9	1020	34	0.88
2	69.4	$ 41,541.47	82	1110	46	0.89
3	84.9	$ 62,576.51	86	1260	53	0.994
4	91.1	$ 69,009.25	92.7	1310	74	1
5	86	$ 47,801.18	72.9	1280	61	0.986
6	89.8	$ 42,605.91	81.4	1180	61	1
7	82.8	$ 55,051.09	85.4	1230	66	0.917
8	82	$ 45,343.40	70.7	1200	60	0.948
9	83.2	$ 37,567.95	89.4	1150	50	1
10	65.7	$ 31,653.21	68.2	1030	36	1
11	78.8	$ 46,348.58	82.4	1230	61	0.878
12	82.3	$ 37,986.09	84.3	1180	59	0.969
13	84.4	$ 83,530.92	76.3	1235	64	0.956
14	52.2	$ 39,805.07	61.3	990	17	1
15	83	$ 63,980.26	89.2	1420	94.9	0.915
16	89.5	$ 81,433.33	87.1	1300	91	0.989
17	68.6	$ 26,970.19	70.1	1060	38	1
18	73	$ 41,452.56	83.8	1190	42	1
19	68	$ 22,341.36	59	1220	70	1
20	67.6	$ 33,759.63	71.8	1002	39	1
21	80.1	$ 48,792.31	64.4	1180	59	0.949
22	90	$ 105,555.09	82	1390	90	1
23	60.4	$ 55,213.41	89.8	1290	65	0.67
24	78.7	$ 35,388.41	82.3	1160	53.2	0.96
25	76.2	$ 49,280.01	89.2	1140	44	0.971
26	83.3	$ 43,411.57	60.1	1180	59	1
27	76.6	$ 48,269.96	71.8	1180	50	0.948
28	71.8	$ 39,769.48	76.8	1200	50	0.882
29	74.4	$ 59,320.28	86.8	1170	57	0.851
30	86.1	$ 65,466.57	89	1320	70	0.95
31	88	$ 52,512.62	75.2	1320	84	1
32	84.3	$ 101,023.41	77	1270	76	0.952
33	80.1	$ 52,200.61	70.1	1240	71	0.927
34	69.1	$ 22,961.76	73.1	1120	43	1

Table A2

Data Envelopment Analysis Input Slacks

College	cost slack	% ft fac slack	SAT slack	top 10% slack
1	$ 35,797.49	0	0	0
2	$ 4,183.23	0	0	0
3	$ 20,456.22	3.589	75.789	0
4	$ -	0	0	0
5	$ 4,546.41	0	95.262	0
6	$ -	0	0	0
7	$ 2,233.08	0	1.125	0
8	$ 2,330.84	0	19.972	0
9	$ -	0	0	0
10	$ -	0	0	0
11	$ 3,742.66	1	50	0
12	$ -	4.852	14.111	2.233
13	$ 39,305.25	0	34.347	0
14	$ -	0	0	0
15	$ -	0	139.874	23.478
16	$ 9,015.87	0	0	15.856
17	$ -	0	0	0
18	$ -	0	0	0
19	$ -	0	0	0
20	$ -	0	0	0
21	$ 5,566.92	0	0	0
22	$ -	0	0	0
23	$ 4,483.39	4.923	70	0
24	$ -	2.067	4.761	0
25	$ 10,495.46	4.615	0	0
26	$ -	0	0	0
27	$ 5,889.65	0	0	0
28	$ -	0	35.973	0
29	$ 18,435.34	2.659	0	0
30	$ 4,544.72	0	50.725	0
31	$ -	0	0	0
32	$ 52,033.23	0	0	0.253
33	$ 5,022.05	0	0	0.954
34	$ -	0	0	0

Table A3

Data Envelopment Analysis Peers and Weights

College	peer 1 (weight)	peer 2 (weight)	peer 3 (weight)	peer 4 (weight)
1	18 (0.056)	9 (0.072)	14 (0.271)	20 (0.6)
2	18 (0.161)	6 (0.084)	9 (0.424)	20 (0.331)
3	6 (0.579)	18 (0.421)		
4	4 (1)			
5	31 (0.034)	6 (0.577)	26 (0.389)	
6	6 (1)			
7	22 (0.014)	4 (0.353)	6 (0.633)	
8	31 (0)	6 (0.498)	26 (0.502)	
9	9 (1)			
10	10 (1)			
11	6 (1)			
12	34 (0.235)	6 (0.765)		
13	31 (0.148)	6 (0.656)	26 (0.196)	
14	14 (1)			
15	4 (0.688)	22 (0.051)	6 (0.261)	
16	4 (0.49)	22 (0.268)	6 (0.242)	
17	17 (1)			
18	18 (1)			
19	19 (1)			
20	20 (1)			
21	18 (0.019)	26 (0.799)	6 (0.181)	14 (0.001)
22	22 (1)			
23	4 (0.308)	6 (0.692)		
24	6 (0.494)	34 (0.32)	9 (0.186)	
25	9 (0.635)	14 (0.123)	18 (0.242)	
26	26 (1)			
27	26 (0.48)	6 (0.024)	18 (0.471)	14 (0.025)
28	18 (0.363)	6 (0.303)	17 (0.163)	26 (0.17)
29	6 (0.647)	9 (0.338)	18 (0.015)	
30	4 (0.672)	22 (0.009)	6 (0.319)	
31	31 (1)			
32	31 (0.643)	6 (0.338)	26 (0.019)	
33	26 (0.406)	6 (0.166)	31 (0.429)	
34	34 (1)			

Appendix B. Regression Results

Table B1

Model Summary

Model	*R*	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics				
					R^2 Change	*F* Change	*df1*	*df2*	Sig. *F* Change
1	.151[a]	.023	-.009	.0453293	.023	.724	1	31	.401
2	.462[b]	.213	.101	.0427991	.190	2.258	3	28	.104
3	.655[c]	.429	.206	.0402254	.216	1.740	5	23	.166
4	.656[d]	.430	.171	.0410870	.001	.045	1	22	.833
5	.663[e]	.439	.103	.0427509	.009	.160	2	20	.853
6	.747[f]	.558	.215	.0399940	.119	2.426	2	18	.117

a. Predictors: (Constant), fall09_enroll

b. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice

c. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head

d. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized

e. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized, num_security_practices, security_risk_assessment

f. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized, num_security_practices, security_risk_assessment, strat_plan_incl_it, top_it_on_cabinet

Table B2

Model ANOVAs

Model		Sum of Squares	*df*	Mean Square	*F*	Sig.
1	Regression	.001	1	.001	.724	.401[a]
	Residual	.064	31	.002		
	Total	.065	32			
2	Regression	.014	4	.003	1.896	.139[b]
	Residual	.051	28	.002		
	Total	.065	32			
3	Regression	.028	9	.003	1.921	.100[c]
	Residual	.037	23	.002		
	Total	.065	32			
4	Regression	.028	10	.003	1.661	.154[d]
	Residual	.037	22	.002		
	Total	.065	32			
5	Regression	.029	12	.002	1.306	.289[e]
	Residual	.037	20	.002		
	Total	.065	32			
6	Regression	.036	14	.003	1.625	.165[f]
	Residual	.029	18	.002		
	Total	.065	32			

a. Predictors: (Constant), fall09_enroll

b. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice

c. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head

d. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized

e. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized, num_security_practices, security_risk_assessment

f. Predictors: (Constant), fall09_enroll, top_it_officer_rank, it_has_strat_plan, total_aligned_advice, outsource_total, Percent Campus Spent on IT, tech_fee, comp_as_pct_funding, Centralized IT Funding Per Head, pct_IT_pers_centralized, num_security_practices, security_risk_assessment, strat_plan_incl_it, top_it_on_cabinet

g. Dependent Variable: vrs te

Table B3

Model Coefficients

Model		Unstandardized Coefficients		Standard Coeff.			85.0% CI for *B*		Collinearity Statistics	
		B	Std. Error	Beta	*t*	Sig.	Lower	Upper	Tol.	*VIF*
1	(Constant)	.937	.029		31.976	.000	.894	.980		
	fall09_enroll	1.198E-5	.000	.151	.851	.401	.000	.000	1.000	1.000
2	(Constant)	1.004	.040		25.395	.000	.946	1.063		
	fall09_enroll	1.143E-5	.000	.144	.855	.400	.000	.000	.987	1.013
	it_has_strat_plan	-.003	.016	-.027	-.161	.873	-.026	.021	.993	1.007
	top_it_officer_rank	-.014	.006	-.404	-2.339	.027	-.023	-.005	.944	1.060
	total_aligned_advice	-.004	.007	-.093	-.541	.593	-.013	.006	.940	1.064
3	(Constant)	1.105	.094		11.732	.000	.965	1.246		
	fall09_enroll	1.535E-6	.000	.019	.104	.918	.000	.000	.710	1.408
	it_has_strat_plan	-.016	.017	-.166	-.914	.370	-.041	.010	.757	1.321
	top_it_officer_rank	-.014	.006	-.396	-2.209	.037	-.023	-.005	.771	1.297
	total_aligned_advice	-.009	.007	-.231	-1.226	.232	-.019	.002	.700	1.428
	Percent Campus Spent on IT	.196	.931	.059	.211	.835	-1.190	1.583	.323	3.099
	Centralized IT Funding Per Head	-8.574E-6	.000	-.094	-.341	.736	.000	.000	.326	3.072
	comp_as_pct_funding	-.069	.097	-.152	-.713	.483	-.213	.075	.547	1.828
	outsource_total	-.012	.005	-.397	-2.368	.027	-.019	-.004	.881	1.135
	tech_fee	-.047	.023	-.378	-1.996	.058	-.082	-.012	.691	1.447

Model		Unstandardized Coefficients		Standard Coeff.			85.0% CI for *B*		Collinearity Statistics	
		B	Std. Error	Beta	*t*	Sig.	Lower	Upper	Tol.	*VIF*
4	(Constant)	1.084	.138		7.873	.000	.879	1.290		
	fall09_enroll	2.103E-6	.000	.027	.137	.892	.000	.000	.689	1.452
	it_has_strat_plan	-.017	.018	-.176	-.920	.368	-.043	.010	.708	1.411
	top_it_officer_rank	-.014	.007	-.389	-2.081	.049	-.024	-.004	.742	1.347
	total_aligned_advice	-.009	.007	-.235	-1.216	.237	-.020	.002	.693	1.443
	Percent Campus Spent on IT	.193	.951	.057	.203	.841	-1.226	1.611	.323	3.101
	Centralized IT Funding Per Head	-7.808E-6	.000	-.086	-.301	.766	.000	.000	.319	3.132
	comp_as_pct_funding	-.071	.099	-.156	-.713	.483	-.218	.077	.544	1.840
	outsource_total	-.012	.005	-.399	-2.326	.030	-.020	-.004	.878	1.139
	tech_fee	-.047	.024	-.381	-1.965	.062	-.083	-.011	.687	1.455
	pct_IT_pers_centralized	.023	.108	.038	.213	.833	-.138	.185	.803	1.246

Model		Unstandardized Coefficients		Standard Coeff.			85.0% CI for *B*		Collinearity Statistics	
		B	Std. Error	Beta	*t*	Sig.	Lower	Upper	Tol.	*VIF*
5	(Constant)	1.021	.182		5.598	.000	.748	1.294		
	fall09_enroll	6.015E-6	.000	.076	.330	.745	.000	.000	.531	1.882
	it_has_strat_plan	-.015	.020	-.162	-.780	.444	-.045	.014	.649	1.541
	top_it_officer_rank	-.013	.007	-.375	-1.917	.070	-.024	-.003	.731	1.367
	total_aligned_advice	-.008	.008	-.216	-1.060	.302	-.020	.003	.674	1.483
	Percent Campus Spent on IT	.054	1.022	.016	.053	.958	-1.475	1.584	.303	3.304
	Centralized IT Funding Per Head	-3.221E-6	.000	-.035	-.114	.910	.000	.000	.293	3.417
	comp_as_pct_funding	-.046	.113	-.101	-.404	.690	-.216	.124	.449	2.227
	outsource_total	-.011	.006	-.380	-2.070	.052	-.020	-.003	.831	1.203
	tech_fee	-.045	.025	-.366	-1.788	.089	-.083	-.007	.670	1.492
	pct_IT_pers_centralized	.041	.117	.068	.348	.732	-.135	.216	.742	1.349
	security_risk_assessment	-.008	.019	-.085	-.391	.700	-.036	.021	.599	1.671
	num_security_practices	.003	.006	.114	.544	.593	-.006	.012	.635	1.576

		Unstandardized Coefficients		Standard Coeff.			85.0% CI for *B*		Collinearity Statistics	
Model		*B*	Std. Error	Beta	*t*	Sig.	Lower	Upper	Tol.	*VIF*
6	(Constant)	.922	.177		5.209	.000	.655	1.188		
	fall09_enroll	5.991E-6	.000	.076	.352	.729	.000	.000	.531	1.882
	it_has_strat_plan	.000	.020	.005	.023	.982	-.029	.030	.557	1.795
	top_it_officer_rank	-.006	.007	-.160	-.766	.454	-.017	.005	.561	1.783
	total_aligned_advice	-.003	.008	-.079	-.387	.703	-.015	.009	.590	1.693
	Percent Campus Spent on IT	.272	.961	.081	.283	.780	-1.173	1.717	.299	3.340
	Centralized IT Funding Per Head	-2.585E-6	.000	-.028	-.098	.923	.000	.000	.293	3.419
	comp_as_pct_funding	-.018	.107	-.040	-.169	.868	-.179	.143	.439	2.275
	outsource_total	-.013	.005	-.439	-2.492	.023	-.021	-.005	.791	1.264
	tech_fee	-.028	.025	-.226	-1.122	.276	-.066	.010	.603	1.658
	pct_IT_pers_centralized	.051	.110	.085	.465	.648	-.114	.216	.740	1.351
	security_risk_assessment	-.010	.018	-.109	-.538	.597	-.037	.017	.595	1.680
	num_security_practices	.005	.006	.169	.851	.406	-.004	.013	.623	1.606
	top_it_on_cabinet	-.039	.019	-.432	-2.071	.053	-.067	-.011	.564	1.773
	strat_plan_incl_it	.028	.020	.261	1.445	.166	-.001	.058	.751	1.331

THE UNIVERSITY OF MEMPHIS

Institutional Review Board

To:	James Eckles Leadership
From:	Chair, Institutional Review Board For the Protection of Human Subjects irb@memphis.edu
Subject:	The Impact of IT Management on the Efficiency of Top Liberal Arts Colleges (121610-335)
Approval Date:	December 22, 2010

This is to notify you that the Institutional Review Board has designated the above referenced protocol as exempt from the full federal regulations. This project was reviewed in accordance with all applicable statuses and regulations as well as ethical principles.

When the project is finished or terminated, please complete the attached Notice of Completion form and send it to the Board via e-mail at irb@memphis.edu.

Approval for this protocol does not expire. However, any change to the protocol must be reviewed and approved by the board prior to implementing the change.

____

Chair, Institutional Review Board
The University of Memphis

Cc: Dr. Katrina Meyer